Aviation Week

Including **Space Technology**

December 1, 1958

How Douglas Produces Nike Hercules

•

Jupiter C With NASA Inflatable Satellite

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For a full description of Rheem Electronics, write for Data File AW-506-1.

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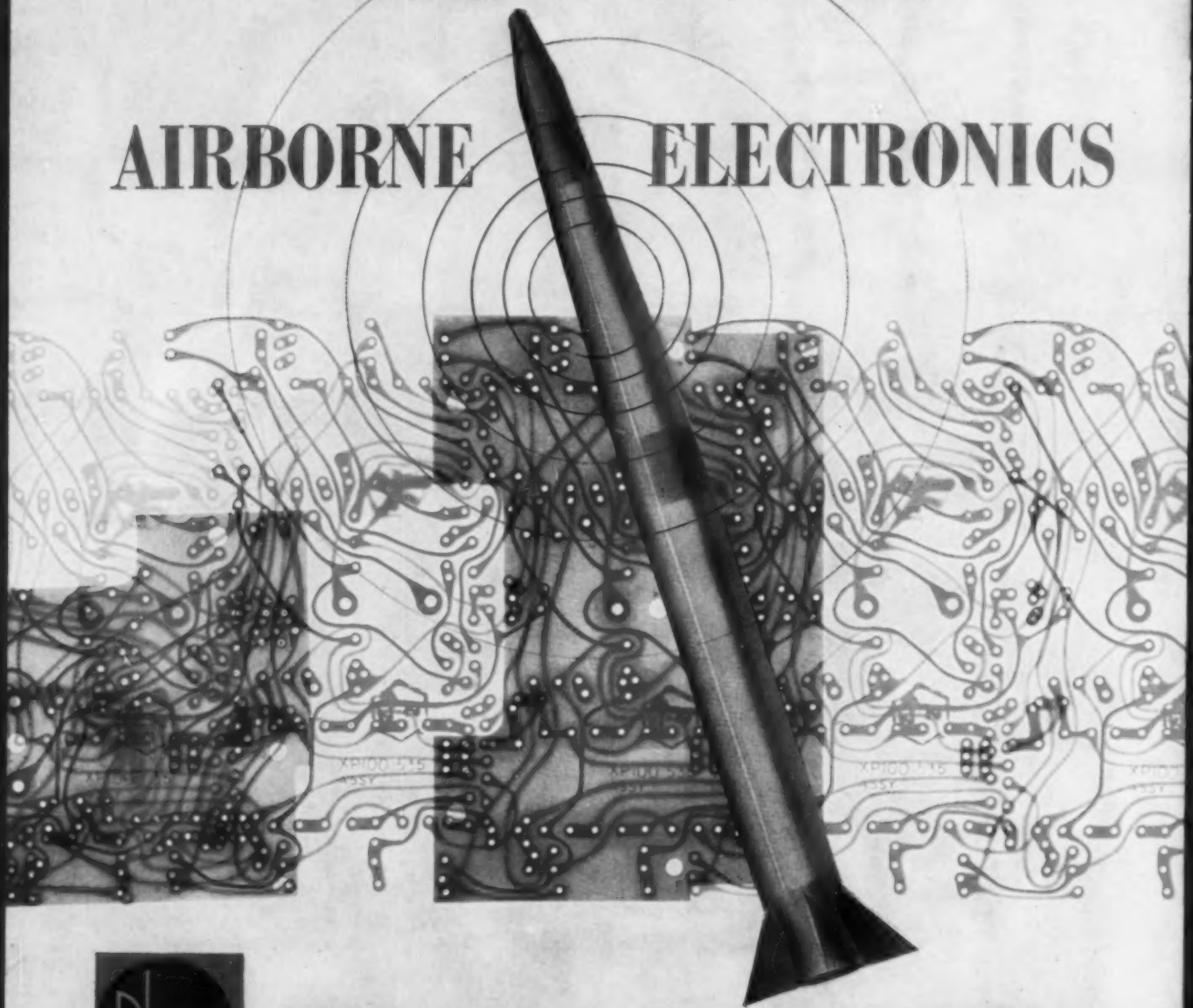

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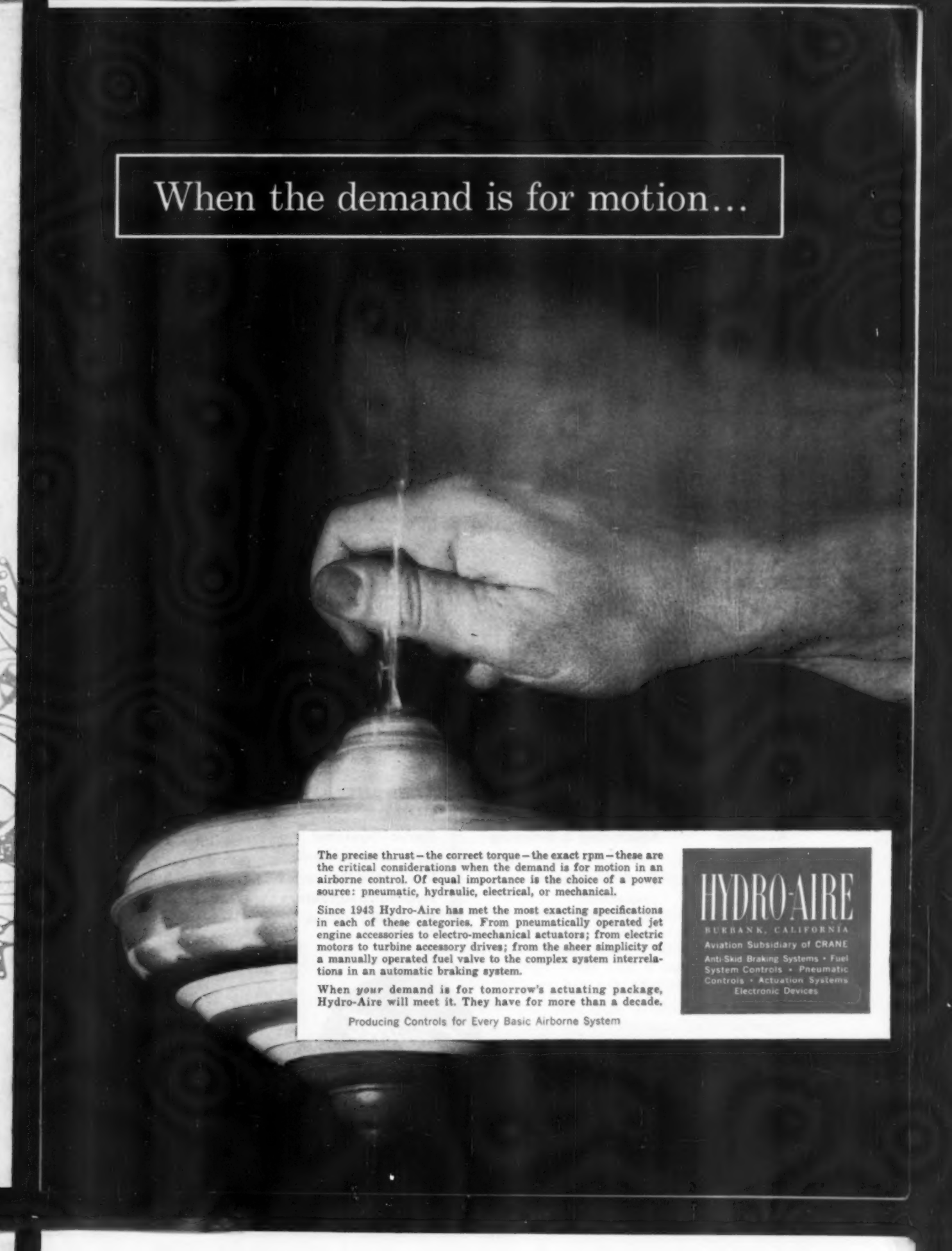
When the demand is for motion...



The precise thrust – the correct torque – the exact rpm – these are the critical considerations when the demand is for motion in an airborne control. Of equal importance is the choice of a power source: pneumatic, hydraulic, electrical, or mechanical.

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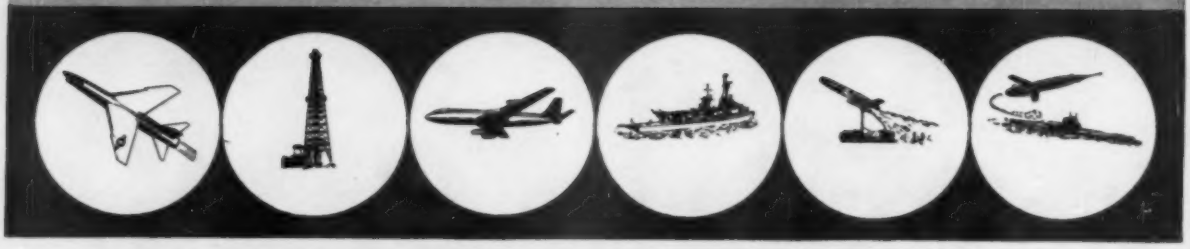

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– U.S. Supreme Court

AVIATION CALENDAR

Dec. 8—Symposium on High Speed Testing, sponsored by Plas-Tech Equipment Corp., Sheraton-Plaza Hotel, Boston, Mass.

Dec. 9-11—Mid-America Electronics Convention, sponsored by Kansas City Section, Institute of Radio Engineers, Municipal Auditorium Arena, Kansas City, Mo.

Dec. 10—First Quarterly Meeting, Society of Aircraft Materials and Process Engineers (SAMPE), Eastern Division, Statler-Hilton Hotel, Washington, D. C.

Dec. 11-13—Southeastern Regional Meeting, American Chemical Society, University of Florida, Gainsville, Fla. Redstone Arsenal scientists will conduct two symposia on Dec. 13: technical papers on missile chemistry and missile chemistry for students and teachers.

Dec. 16—Fourth Convertible Aircraft Congress, the Franklin Institute, Philadelphia, Pa. (Changed from Nov. 28)

Dec. 17—22nd Wright Brothers Lecture, Maurice Roy on French aeronautical research, Natural History Bldg., Smithsonian Institution, Washington, D. C.

Dec. 27-30—Fifth Annual Meeting, American Astronautical Society, Hotel Statler, Washington, D. C. Meeting will be held in conjunction with the 125th Annual Meeting of the American Assn. for the Advancement of Science.

Dec. 27-30—Fifth King Orange International Model Plane Meet, Miami, Fla.

Jan. 12-14—Fifth National Symposium on Reliability and Quality Control in Electronics, Bellevue-Statler Hotel, Philadelphia, Pa.

Jan. 19-21—11th Annual Convention, Helicopter Assn. of America, Villa Hotel, San Mateo, Calif.

Jan. 26-29—27th Annual Meeting, Institute of the Aeronautical Sciences, Shera-

(Continued on page 6)

AVIATION WEEK Including Space Technology

December 1, 1958

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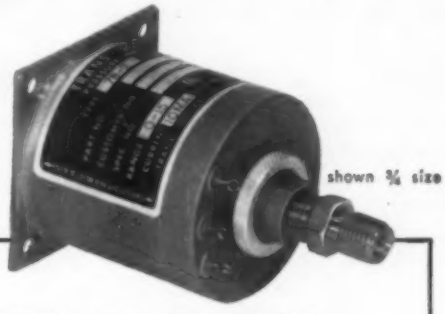

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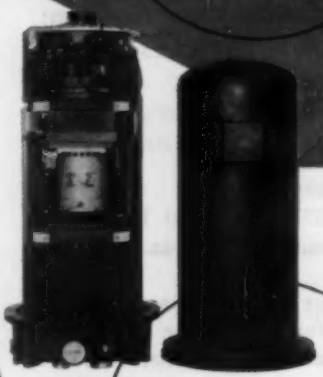

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AVIATION CALENDAR

(Continued from page 5)

ton-Astor Hotel, New York, N. Y. Honors Night Dinner, Jan. 27.

Jan. 27-29—Fifth Annual Radar Symposium (classified), Rockham Bldg., University of Michigan, Ann Arbor, Mich.

Jan. 27-30—15th Annual Technical Conference, Society of Plastics Engineers, Hotel Commodore, New York, N. Y.

Jan. 28-29—Fifth Annual Midwest Welding Conference, sponsored by Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill.

Feb. 3-5—14th Annual Technical and Management Conference, Reinforced Plastics Division, Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago.

Feb. 12-13—1959 Solid State Circuits Conference, sponsored by Institute of Radio Engineers' Professional Group on Circuit Theory, American Institute of Electrical Engineers' Committee on Electronics and University of Pennsylvania, Philadelphia.

Feb. 21-22—13th Annual Pacific Coast Mid-Winter Soaring Championships, Torrey Pines Gliderport, San Diego, Calif.

Feb. 26-March 1—1959 Engineering Exposition, Balboa Park, San Diego, Calif. Address inquiries to: 422 Land Title Bldg., San Diego 1, Calif.

March 3-5—1959 Western Joint Computer Conference, sponsored by Institute of Radio Engineers, American Institute of Electrical Engineers and Assn. for Computing Machinery, Fairmont Hotel, San Francisco, Calif.

March 5-6—Flight Propulsion Meeting (classified), Institute of the Aeronautical Sciences, Hotel Carter, Cleveland, Ohio.

March 5-7—Western Space Age Conference and Exhibit. For information: Domestic Trade Dept., Los Angeles Chamber of Commerce, 404 South Bixel St., Los Angeles 54, Calif.

March 8-11—Engineering meeting on the turbine in action, sponsored by Gas Turbine Division of the American Society of Mechanical Engineers, Cincinnati, Ohio.

March 16-20—11th Western Metal Exposition and Congress, American Society for Metals, Pan-Pacific Auditorium and Ambassador Hotel, Los Angeles, Calif.

March 23-26—National Convention, Institute of Radio Engineers, Coliseum and Waldorf-Astoria Hotel, New York, N. Y.

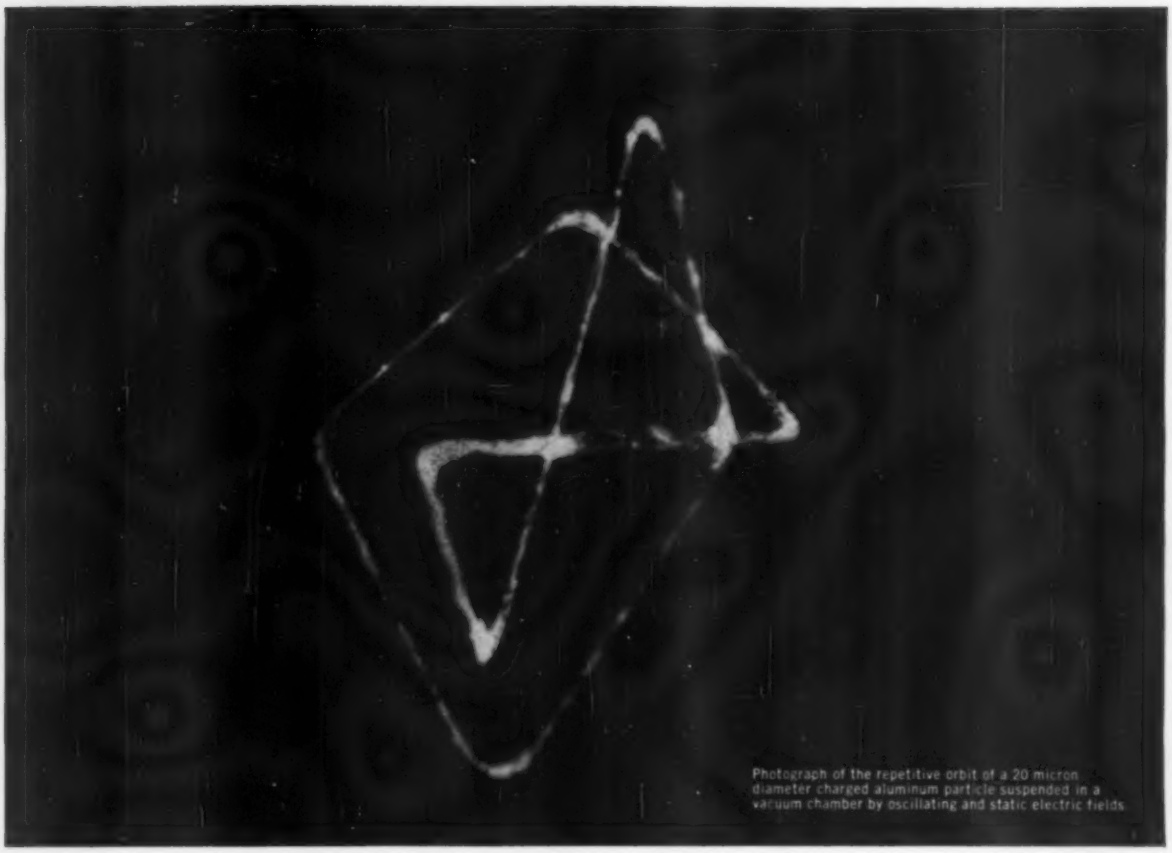
March 31-Apr. 2—Polytechnic Institute of Brooklyn's Ninth International Symposium. Subject: Millimeter Waves. Auditorium, Engineering Societies Bldg., New York, N. Y. Co-sponsors: Department of Defense Research Agencies and Institute of Radio Engineers.

March 31-Apr. 3—National Aeronautic Meeting, Society of Automotive Engineers, Hotel Commodore, New York, N. Y.

Apr. 5-10—1959 Nuclear Congress. Municipal Auditorium, Cleveland, Ohio. For information: Engineers Joint Council, 29 West 39th St., New York 18, N. Y.

Apr. 7-10—1959 Welding Show and 40th Annual Convention, American Welding Society, International Amphitheatre and Hotel Sherman, Chicago, Ill.

Apr. 12-19—Air Force Assn.'s World Congress of Flight, Las Vegas, Nev.



Photograph of the repetitive orbit of a 20 micron diameter charged aluminum particle suspended in a vacuum chamber by oscillating and static electric fields.

ELECTRODYNAMIC ORBITS

By the application of properly chosen alternating and static electric fields, electrically charged particles can be maintained in dynamic equilibrium in a vacuum against interparticle and gravitational forces. This is illustrated in the above photograph of the orbit of a charged dust particle. During the time of exposure the particle traversed the closed orbit several times, yet it retraced its complicated path so accurately that its various passages can barely be distinguished.

The range of particles of different charge-to-mass ratios which can be contained in this manner is determined by the gradients of the static and alternating electric field intensities and by the frequencies of the latter. In the absence of static fields and for a given electric field strength, the minimum frequency required for stable containment of the particles is proportional to the square root of their charge-to-mass ratios. Thus, charged colloidal particles require the use of audio frequencies, atomic ions need HF frequencies, while electrons require the use of VHF and higher frequencies.

Under the confining influence of the external fields, the particles are forced to vibrate with a lower frequency of motion which is determined by the external field intensities, space charge, and the driving frequencies. If the initial thermal energy is removed, a number of particles may be suspended in space in the form of a crystalline array which reflects the symmetry properties of the external electrodes. These "space crystals" can be repeatedly "melted" and re-formed by increasing and decreasing the effective electrical binding force. These techniques offer a new approach in the study of plasma problems and mass spectroscopy in what may be properly termed "Electrohydrodynamics."

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Pressure Shock
0 to 3000 psi in ½ second

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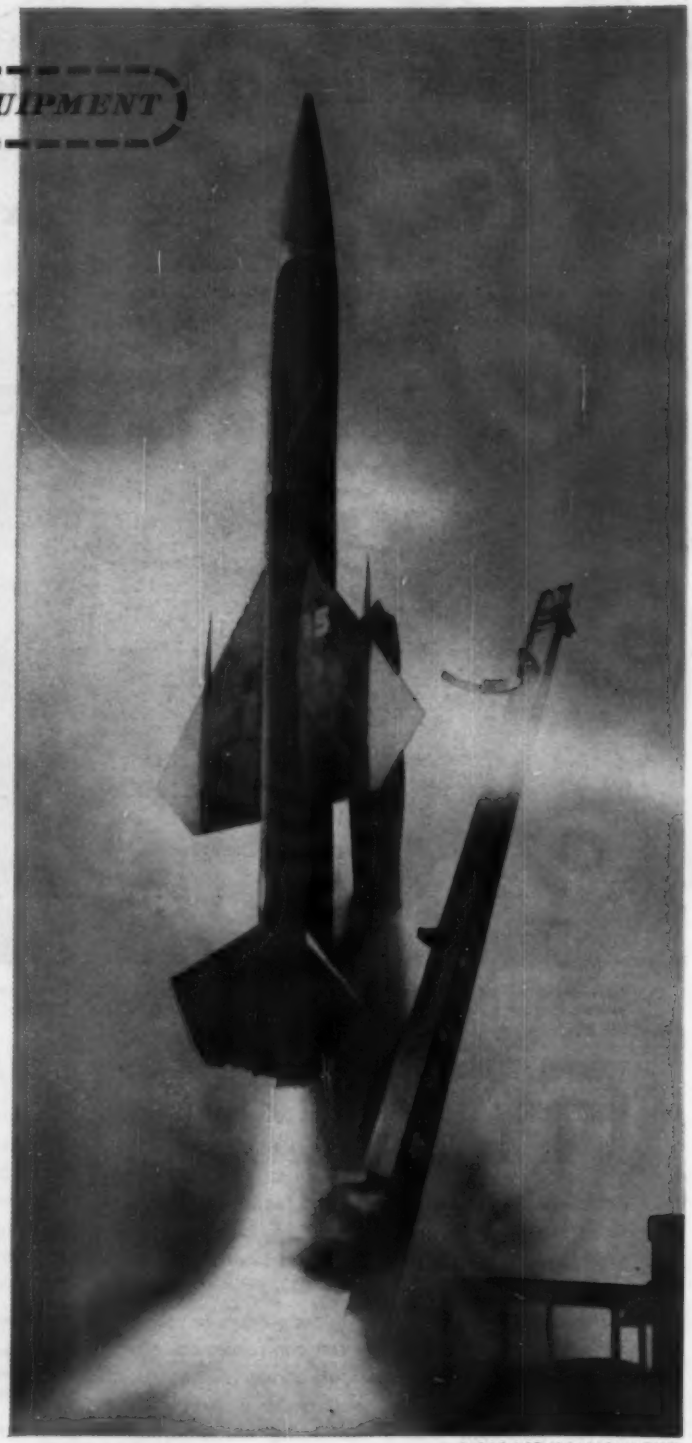

Operated by the Air Defense Command, a Boeing Bomarc climbs skyward from its launcher. FMC is building ground support equipment for this supersonic missile.

BOEING AIRPLANE COMPANY PHOTO

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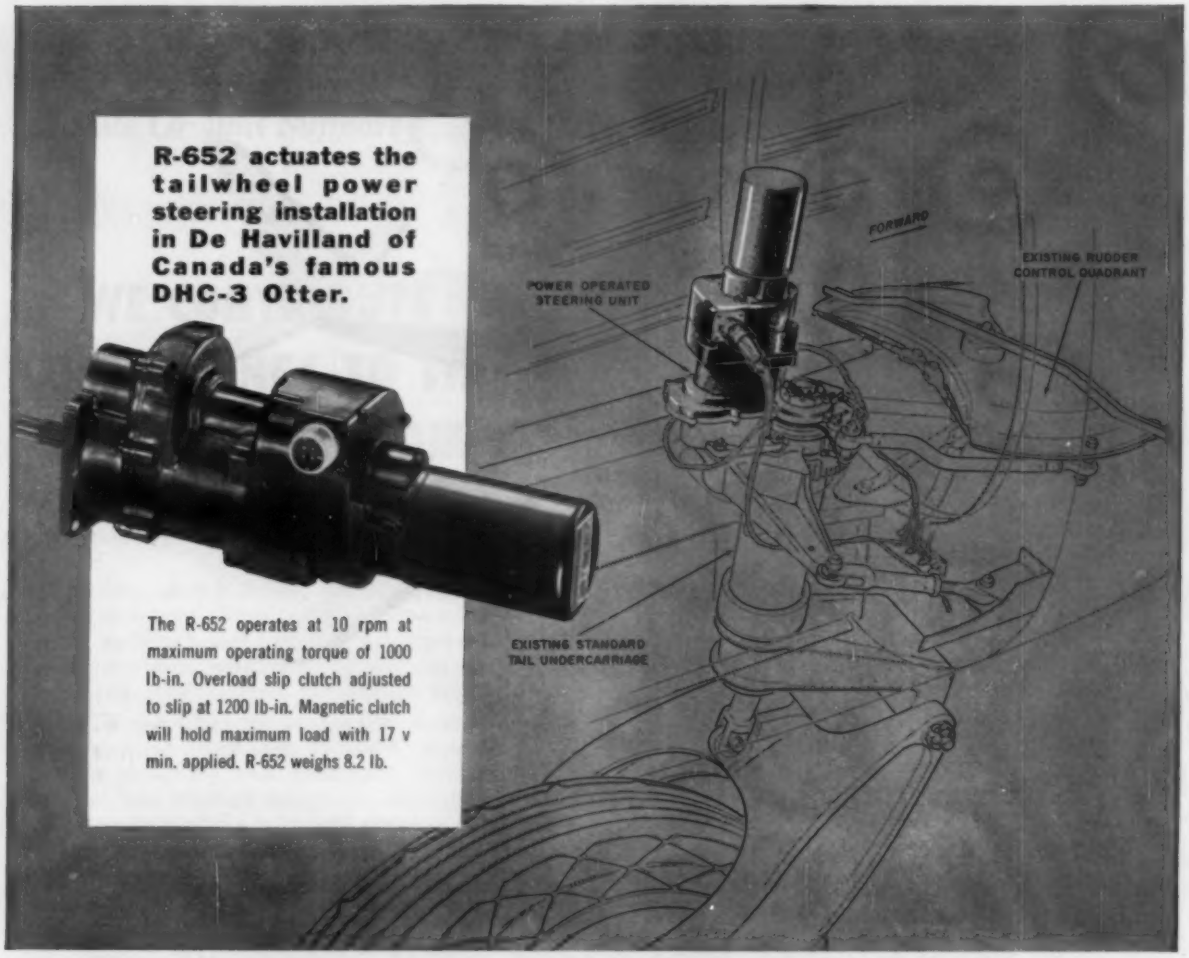
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The R-652 operates at 10 rpm at maximum operating torque of 1000 lb-in. Overload slip clutch adjusted to slip at 1200 lb-in. Magnetic clutch will hold maximum load with 17 v min. applied. R-652 weighs 8.2 lb.
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Drawing courtesy De Havilland Aircraft of Canada, Ltd.

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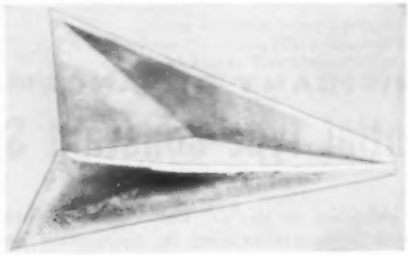
Today Solar is stretch forming brazed, all-metal honeycomb sandwich panels like this one for use in advanced airframe structures.



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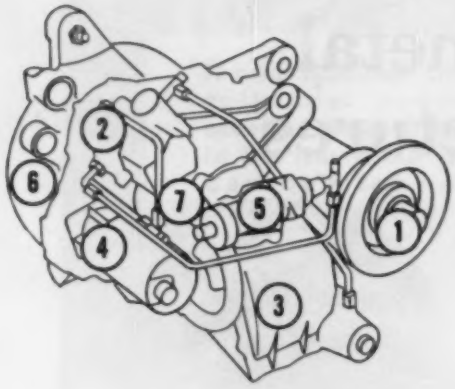

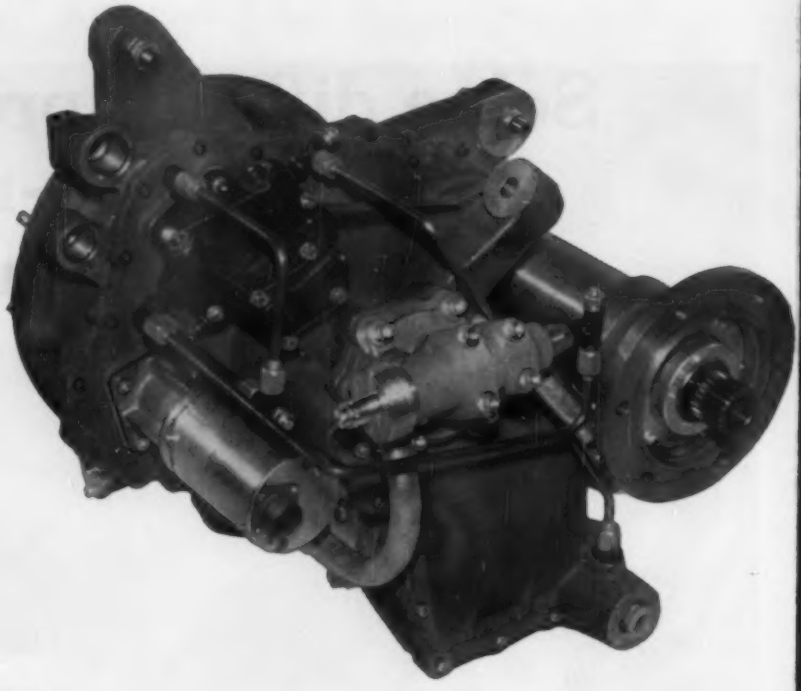

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3 —VARIABLE DISPLACEMENT PUMP/MOTOR
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4 —OVERSPEED GOVERNOR
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5 —MAIN SYSTEM RELIEF VALVE
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6 —DIFFERENTIAL GEAR SECTION
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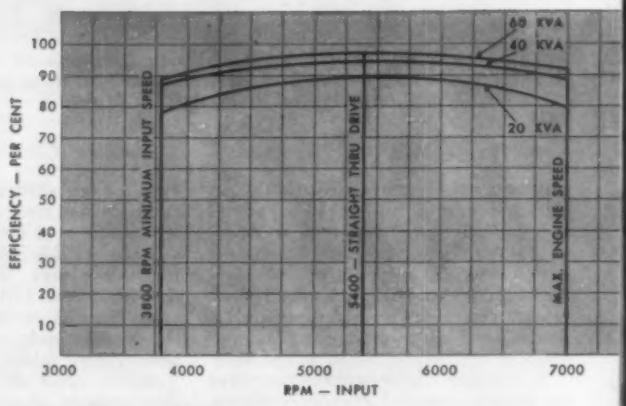

Performance of Vickers 60 kva Differential Type Constant Speed Drive at three different loads. The high efficiency requires minimum support equipment for cooling with minimum penalty for high temperature operation (400°F oil temp.)

December 1, 1958

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Including Space Technology

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EDITORIAL

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COVER: Army Ballistic Missile Agency's Jupiter satellite vehicle, composed of a modified Redstone missile and 15 solid rockets, is launched at Cape Canaveral, Fla. This vehicle, powered by Rocketdyne engine, carried a National Aeronautics and Space Administration inflatable sphere in the Explorer VI satellite, but upper stages apparently did not fire properly and the launch was unsuccessful. Vehicle has had three successful missile test firings, three successful satellite launchings, three satellite failures. California Institute of Technology's Jet Propulsion Laboratory is co-developer. See photos and story, pages 48 and 49.

PICTURE CREDITS

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The Soviet Nuclear-Powered Bomber

On page 27 of this issue we are publishing the first account of the Soviet nuclear-powered bomber prototype along with engineering sketches in as much detail as available data permits.

Appearance of this nuclear-powered military prototype comes as a sickening shock to the many dedicated U.S. Air Force and naval aviation officers, Atomic Energy Commission technicians and industry engineers who have been working doggedly on our own nuclear aircraft propulsion program despite financial starvation, scientific scoffing and top-level indifference. For, once again, the Soviets have beaten us needlessly to a significant technical punch.

While this Soviet achievement is a truly remarkable feat, it is not beyond the technical state of the art in our own nuclear aircraft propulsion program. The difference lies rather in the top priority and steadfast support accorded the Soviet program by its top political leadership and the technical timidity, penny-pinching and lack of vision that have characterized our own political leaders' attitude toward the goal of nuclear-powered aircraft for both military and civil purposes.

This is a story that has become all too familiar to Americans in recent years, punctuated by the Soviet triumphs with the first medium-range ballistic missile in production and military deployment; the first successful ICBM firings followed by an ICBM production rate that is now more than 15 per month, and the trio of Sputniks. This also could be the epitaph carved on the tombstone of this country's genuine technical development capability if we continue much longer on this course.

We are sure that there will be the usual chorus of good gray voices from high official places attempting to "pooh pooh" the existence of a Soviet nuclear-powered bomber prototype and coining smooth weasel-worded phrases to deprecate its significance even if its existence is finally admitted, as finally it must be. For the basic facts on this Soviet aircraft are known in official circles both here and abroad.

The credibility of the same "gray voices" has, of course, diminished in recent years because they used the same tone and phrases to soothe the country before the appearance of Soviet nuclear weapons, intercontinental bombers, supersonic fighters, medium-range missiles, the ICBM and the Sputnik.

Maj. Gen. Donald Keirn, chief of the USAF-AEC aircraft nuclear propulsion program, virtually let the cat out of the official bag in the question period after a speech in Washington last month by admitting that it would not surprise him if the Soviets flew a nuclear-powered aircraft before the end of 1958. This was like placing a bet on a horse race after you have watched it finish through binoculars and have found a bookmaker who doesn't have a phone.

With an acute awareness that the first world-wide demonstration of the Soviet nuclear plane would generate a major political blast, Gen. Keirn also pointed the finger of responsibility for our own slow progress at the sources who are really at fault. These are the anonymous scientists headed by James Killian, scientific advisor to the President, who operate under a heavy veil of official secrecy and only last spring vetoed a military-industry proposal to accelerate nuclear aircraft development on the basis of promising technical achievement.

Although not mentioned by Gen. Keirn, former Secretary of Defense Charles E. Wilson also must answer for his jeering characterization in 1957 of an atomic-powered plane as a "shitepoke," a bird that has a long neck, big body and can fly, but not very fast, and for his 1953 attempt to wipe out the entire aircraft nuclear propulsion program by cutting off its development funds. The late Harold Talbott, then Secretary of the Air Force, circumvented this Wilson order by diverting some "hidden" USAF funds to the program. AEC also maintained its support.

Since word of the Soviet nuclear-powered aircraft began filtering through the Iron Curtain, the pentagon has hastily revived an active program aimed at a nuclear-powered military aircraft known as the CAMAL project. Mission of this aircraft is described by Gen. Keirn on page 28. Think of the political and military significance of even a small fleet of nuclear-powered military aircraft that, as Gen. Keirn described, can cruise indefinitely off the territorial limits of the U.S. maintaining a continuous airborne alert and warning system combined with the capability of quick launching of missiles with sufficient range to penetrate 1,000 mi. or more and following up this attack with a high-speed, low-level penetration well under and around radar defenses to obliterate key targets missiles cannot locate. It takes no military expert to appreciate the value of this apparatus in the hands of an aggressive, ambitious political dictatorship bent on world conquest.

The development of a nuclear-powered military aircraft involves much more than just producing a satisfactory powerplant, and this is a phase in which we lag even farther behind than in engine development. Every time the financial pinch was applied to the nuclear aircraft program, those in charge, of necessity, starved aircraft systems development to keep the powerplant research alive.

Thus, with the Soviets now in the initial flight testing of a nuclear-powered military prototype and the Air Research and Development Command scheduled only this month to make a decision on prototype construction of a similar USAF weapon system, it is clear to even the most conservative technical analysts that we are at least four years behind the Russians in this critical area. Development of such a new and technically radical weapon system to full military capability is a long, painstaking and failure-studded process on both sides of the Iron Curtain. But with such a clear-cut lead, we can expect the Soviets to exploit their nuclear-powered aircraft for political warfare long before it has developed a sound military capability. There already are indications that a nonstop, non-refueled flight several times around the world is being planned by the Soviets with this type aircraft. And, how much political force will an event such as this impact on our allies, the neutrals and our enemies?

During the past few years, we have heard much from our political leaders on how much we can or cannot "afford" for the defense of this country.

These were the same years that we have been belabored with vigorous efforts to cut the strength of our military forces in being and jeopardize our military future by sabre slashes through the research and development budget.

These were the same years the Soviets appeared first with their huge turbojet and turboprop gas turbines, their medium-range ballistic missiles, ICBM and Sputniks.

In view of these Soviet technical achievements, it is more pertinent to ask:

How much longer can we "afford" this kind of leadership and still survive as a free nation?

—Robert Hotz

which of these

nine missile hydraulic power problems face you today?

PROBLEM

weight and space Eastern hydraulic power units are made of *miniature* high-speed gear pumps, close-coupled directly to performance-tested electric motors. Even when components are added such as reservoir, expansion-relief valve, expansion bellows, adjustable pressure-regulating valve, check valves — total weight is under 5 pounds, size only 7¾" x 2¾" x 7¾" (Eastern unit illustrated used as example).

PROBLEM

high temperatures Most Eastern units normally operate at temperature range of −67°F. to +220°F. Higher temperature limits are no problem.

PROBLEM

reliability The necessity for high performance and reliability in executing commands of the guidance system, makes hydraulic systems a vital link in performance. Eastern systems have gained the reputation for outstanding reliability under extreme environmental conditions when operating at high speeds.

PROBLEM

high-speed power take-off Eastern gear pumps with speeds of 24,000 RPM permit direct drive by main power source.

PROBLEM

complicated, heavy plumbing Running lines from power unit to remote areas can be eliminated by using individual self-contained hydraulic power units at each point. You gain maximum flexibility, simplicity, reliability, while removing more weight in plumbing than you add in power packs.

PROBLEM

compromised accessory performance When all accessories adapt the 3000 PSI main system pressure by means of power-wasting, heat-producing, pressure-reducing valves, performance suffers. Eastern units offer individually selected hydraulic fluids and pressures to give optimum performance to each accessory in the system. Eastern units have capacity to 1.5 GPM at pressures to 3000 PSI.

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PROBLEM

fluid contamination System cleanliness is insured by a sealed system and continuous filtering of pump discharge.

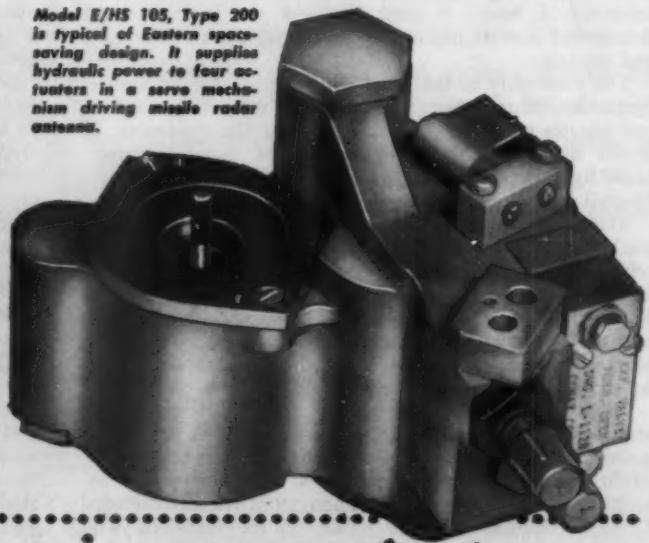
PROBLEM

runaway costs Eastern uses standard mass-produced components, arranges them to match your space, to give you a custom design with minimum development expense.

PROBLEM

divided responsibility Eastern welcomes the opportunity to develop components or complete missile subsystems in hydraulic power, electronic cooling and refrigeration, and pressurization. Design and manufacturing responsibility from one experienced source is your assurance of dependable performance. Write, phone, wire for complete information.

Model E/HS 105, Type 200 is typical of Eastern space-saving design. It supplies hydraulic power to four actuators in a servo mechanism driving missile radar antenna.



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WHO'S WHERE

In the Front Office

George H. Nibbe, president, Canoga Division, Underwood Corp., Van Nuys, Calif. Also: **Joe G. McCann**, vice president, and **George J. Hartman**, treasurer.

International Telephone and Telegraph Corp. has named its recently consolidated Clifton, N. J., and Fort Wayne, Ind., divisions the ITT Federal Division, and elected the following officers: **George A. Banino**, vice president-comptroller; **Robert E. Chasen**, vice president-administration; **Theodore M. Douglas**, division vice president; **Walter W. Hawk**, vice president-engineering; **William B. Levet**, secretary-counsel.

Dr. Joseph T. deBettencourt, vice president-research and development, D. S. Kennedy & Co., Cohasset, Mass.

Frank C. Mullaney, a vice president, and **Edward Strickland**, treasurer, Control Data Corp., Minneapolis, Minn.

R. G. McCoy, general manager, and **D. R. Newman**, chief aerodynamicist, de Havilland Aircraft Company Ltd., Hatfield, England.

Maj. Gen. Harold H. Bassett has assumed command of the USAF Air Weather Service, Scott AFB, Ill.

Honors and Elections

Ernst Weber, president of Polytechnic Institute of Brooklyn, has been elected president of the Institute of Radio Engineers for 1959; **Donald B. Sinclair**, vice president and chief engineer of General Radio Co., was elected vice president. Elected as directors for 1959-61 were: **Ferdinand Hamburger, Jr.**, Professor of Electrical Engineering at Johns Hopkins University, and **Bernard M. Oliver**, vice president-research and development of Hewlett-Packard Co.

W. Clayton Lemon, of Roanoke Air Taxi Service, has been elected president of the National Air Taxi Conference for 1959. Elected vice presidents were: **Julius Goldman**, of Revere Airways, and **W. Frank Wilkinson**, of Aviation Services, Inc.

Changes

Dr. Edgar L. Armi, chief-research staff, Advanced Engineering Dept., Autonetics Division of North American Aviation, Inc., Downey, Calif. Also: **Dr. W. J. West**, project engineer for reliability on Weapon System 133A (Minuteman).

T. Courtenay Wakefield, chief-systems design, Electronics Division, Curtiss-Wright Corp., Carlstadt, N. J.

Dan H. Jacobson, chief research and design engineer of the newly-formed Advanced Research and Development Group, Aeroproducts Operations, Allison Division, General Motors Corp., Dayton, Ohio.

William M. Watkins, supervisor, Identification and Traffic Control Unit, Navigation Section, Hoffman Laboratories Division, Hoffman Electronics Corp., Los Angeles.

Capt. Upton S. Brady (USN, ret.) appointed to the general manager's staff, Bendix Products Division-Missiles, Bendix Aviation Corp., Mishawaka, Ind. Also: **R. R. Wendt**, assistant quality manager.

(*Continued on page 97*)

INDUSTRY OBSERVER

► State Department is dickering with Mexico for use of Lower California sites for tracking installations as part of the new Pacific Missile Test Range. Other negotiations are under way for tracking and telemetry sites on Pacific islands owned by France and Peru. Sites probably would be operated by commercial organizations to avoid international complications.

► **Northrop Aircraft's Radioplane Division has submitted proposals for the drone to be carried by North American F-108 Mach 3 long-range interceptor.**

► Air Force probably will use one of the two Thor-Able space research vehicles still assigned for NASA missions as another lunar probe rather than for a mission to Venus. USAF feels it should solve the moon shot problem first before attempting longer ranging space probes.

► **Watch for North American Aviation's Rocketdyne Division to receive an Air Force contract for development of a large fluorine engine, probably as a follow-on project to the smaller fluorine engine developed by Bell Aircraft (AW Sept. 1, p. 23).**

► New airborne three-dimension radar, developed by General Electric, has been included as part of proposals for new Air Force airborne early warning (AEW) aircraft by all four airframe companies that submitted bids—Boeing, Convair, Douglas and Lockheed (AW Nov. 24, p. 35). New 3-D radar, which will replace separate surveillance and height-finder radars now used on AEW aircraft, was developed under Wright Air Development sponsorship.

► **In first test firing of the Martin Co.'s Titan intercontinental ballistic missile, presently scheduled for late this month from Cape Canaveral, Fla., booster stage only will be tested. Second stage will be a dummy. Air Force believes Titan will have use as a penetration weapon even after the advent of the follow-on Minuteman program because of its much larger payload.**

► North American Rocketdyne's 1.5 million lb. single-rocket thrust chamber, designated the F-1, would have a running time of approximately 150 sec., propellant flow rates from 5,000 to 6,000 lb./sec. Over-all length of the unit would be about 15 to 19 ft. long—including combustion chamber and nozzle but without associated pumps and plumbing—with the nozzle mouth diameter almost the same size.

► **Slightly less than 4,000 missiles, exclusive of air-to-air types, are scheduled for manufacture in the U. S. in 1959. Boeing Bomarc production apparently will be heavily emphasized during the next two years.**

► Later versions of the 2,000 lb. thrust General Electric J85 turbojet engine have been modified to include an additional compressor stage for a total of eight. New compressor is designed to give engine its target pressure ratio of 7-1 which had not been reached with the original seven-stage design.

► **Convair is developing a capsule escape system as part of the work by an industry escape system committee. Unit also will be proposed for use in Convair B-58 bombers.**

► Construction of a sixth Air Force intercontinental ballistic missile site is scheduled to begin early next year at Forbes AFB, Kans. Technical design of the $30 million facility will be under the Air Force Ballistic Missile Division; actual construction will be conducted by Army Corps of Engineers. Other ICBM sites are scheduled for Vandenburg AFB, Calif.; Francis E. Warren AFB, Wyo.; Fairchild AFB, Wash.; Lowry AFB, Colo., and Offutt AFB, Nev.

► **Launching sites for later versions of the Atlas intercontinental ballistic missile will be "toughened" through the use of concrete and steel revetments as defensive measures. Early versions of the Atlas will be fired from soft sites, which provide relatively little protection for the missiles in above-ground launching stands. Completely hardened, underground sites are planned for the Titan and Minuteman.**

GO ••• NO-GO

Automatic checkout equipment is a project of J. G. Ferguson, Senior Staff Engineer, Stavid Engineering, Inc.

Mr. Ferguson has specialized in the development of frequency standards for Loran and other navigation systems, field transmission measuring apparatus, cathode ray tube displays, and many other test and measuring devices for electronic equipment. His current work at Stavid is to develop equipment for reliability studies and automatic testing of electronic systems. Mr. Ferguson is one of a team of Stavid scientists and engineers who are applying their knowledge ... from concept through production ... to projects of major importance to the defense and progress of our country.

In Stavid's objective engineering atmosphere, scientific, development and manufacturing teams are producing a wide range of electronic systems for all branches of the military. A typical project is the development of an Airborne Search, Bombing and Terrain Clearance Radar System.

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Washington Roundup

Defense Budget Battle

Department of Defense Fiscal 1960 budget was due to be presented to President Eisenhower over last weekend at his Augusta, Ga., golfing retreat by Defense Secretary McElroy and his entourage. Bureau of the Budget has taken the strongest hand in post-war history in chopping specific military programs by name. Budget Bureau normally gives military services a fiscal ceiling and allows them to allocate money for projects within the services. Now, however, Budget Bureau is ordering specific projects cancelled by the military.

Among the programs already scrapped are the $140 million voted by Congress specifically for development of a better strategic airlift and the Convair F-106 supersonic all-weather interceptor program. Still marginal, with a Budget Bureau veto but a strong Defense Department rebuttal, are the North American B-70 and F-108 Mach 3 bomber and interceptor development programs and the Convair B-58 Mach 2 bomber production program. Present plans call for Mr. McElroy and his deputy, Donald Quarles, to do the major Fiscal 1960 budget presentation before Congress, keeping military leaders in the Pentagon and producing them only on specific request from Congress.

Military Procurement Law

At the same time, both Sen. Lyndon Johnson (D-Tex.), Senate majority leader, and Perkins McGuire, Assistant Secretary of Defense for Supply and Logistics, say they favor a review of the military procurement law by the new Congress with the primary objective of cutting lead time to expedite advanced weapon development and production.

Legislation, introduced in the past session and due to be reintroduced in the new session by Sen. Leverett Saltonstall (R-Mass.), aims to accomplish this by establishing performance specifications, encouraging fixed-price and incentive-type contracts and exempting such contracts from renegotiation (AW Aug. 18, p. 26).

Johnson had endorsed the objectives of the Saltonstall bill. He stated in a letter to Saltonstall that congressional testimony has made it abundantly clear that steps must be taken to improve procurement procedures if modern weapons are to be obtained at the earliest possible time. Johnson said he hopes the new session will produce legislation that "will go far toward eliminating the obstacles which delay the early procurement of necessary defense items."

McGuire wrote Saltonstall: "We are vitally interested in progressive procurement legislation and especially in methods for reducing the lead time required for developing and producing new military weapons systems."

Saltonstall's legislation reflects the views of J. Sterling Livingston, professor of business administration at Harvard Graduate School of Business, and Frank Pace, president of General Dynamics Corp.

Divided Opinion

Sentiment to the Saltonstall procurement bill in other quarters is divided:

• **Strategic Industries Assn. endorses** the bill's provisions to encourage competitive negotiation as an alternative to advertised bid contracts and to exempt incentive type contracts from renegotiation. Other small business interests, however, charge that the bill's policy of expanding weapons system type procurement "will virtually eliminate small business from military procurement."

• **Thomas Coggeshall,** chairman of the Renegotiation Board, will oppose watering down the renegotiation law by exempting fixed-price and incentive-type contracts. Robert Dechert, general counsel, has indicated that Department of Defense will firmly support Coggeshall's position.

• **U. S. Chamber of Commerce** will give general industry support to Saltonstall's measure. The Chamber opposes the bill's provision which "requires" prime contractors to give preferential treatment to small businesses in the award of subcontracts but is not expected to make an open fight against it. Existing law simply states a policy of preferential small business treatment, but is not mandatory.

Vandenberg: Briefly Opened . . .

Launch of a Douglas Thor intermediate range ballistic missile inaugurating the operation of Vandenberg AFB, Calif., will be an open shot, according to Murray Snyder, Assistant Secretary of Defense for Public Affairs. Initial launch is scheduled to take place over the Pacific Missile Range early this month. It will be launched by a crew from the 704th Strategic Missile Wing and will be the first ballistic missile fired from the West Coast. In addition to launches conducted by Strategic Air Command, other projects assigned by the Advanced Research Projects Agency and NASA will be conducted at Vandenberg and the naval missile facility, Pt. Arguello, Calif.

. . . But Tight Security Planned

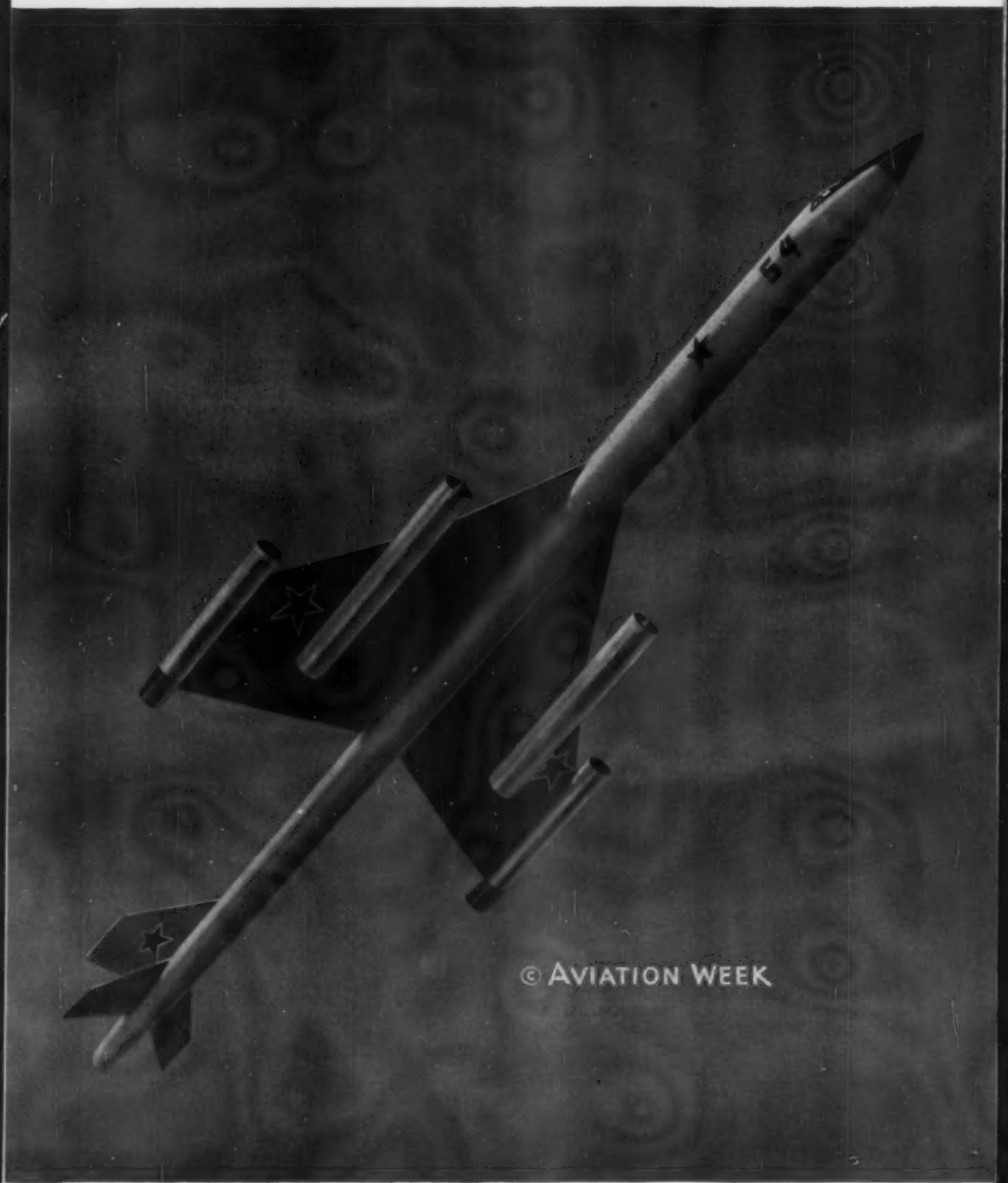
Despite plans for a public inaugural shot, present plans call for a tight security lid to be clamped on the Pacific Missile Range-Vandenberg complex. This was emphasized last week by Rear Adm. Jack P. Monroe, range commander of PMR. Monroe cited the ease of maintaining secrecy as one of the chief advantages of the location of the naval missile facility at Pt. Arguello and at Vandenberg and said there probably would be no announcement of what missiles are to be fired from the complex, when they are fired, or any information concerning success or failures. "We simply cannot afford to make available to Russia the amount of information which has been published in the past," he said. Monroe, whose Pacific Missile Range organization has no responsibility for security on launchings from Vandenberg AFB, also said he expects the Pacific range to grow into a larger operation than the Atlantic missile range at Cape Canaveral, Fla.

He added that PMR will in no way compete with either the Atlantic range or the White Sands, N. M., range, but will complement them.

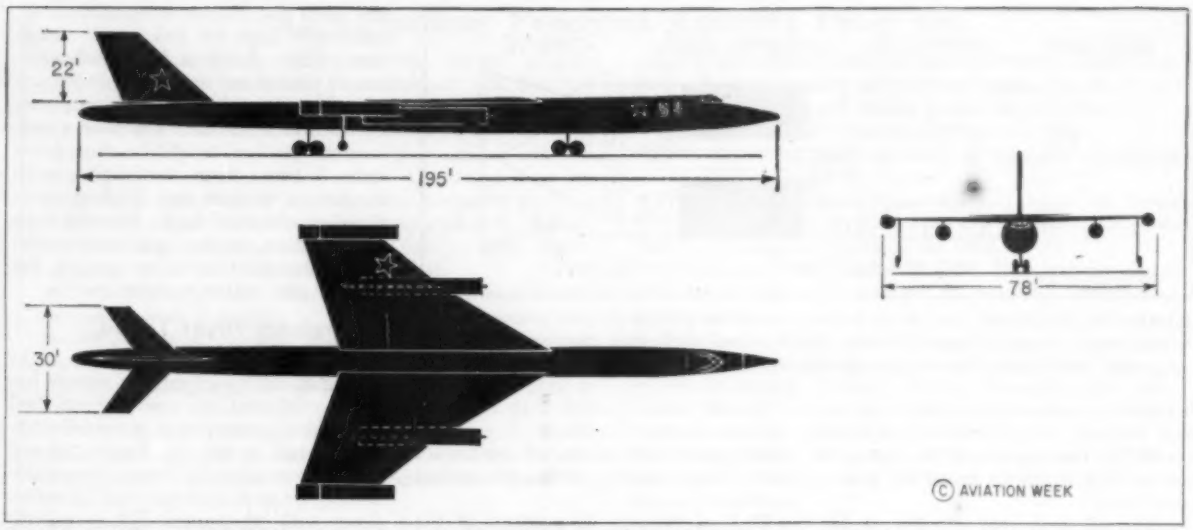
Hazardous Contracts

The President will urge Congress to pass legislation authorizing Department of Defense to indemnify contractors working on hazardous production contracts. The Department asked for the legislation this year, but the Armed Services committees failed to act on the measure. There already is authorization to indemnify contractors working on military research and development contracts.

—**Washington staff**



AVIATION WEEK ARTIST'S conception of Soviet nuclear-powered bomber shows large nuclear powerplants suspended from pods midway under delta wing; conventional turbojets with short takeoff afterburners on wingtips, and 195-ft. fuselage to aid in radiation protection.



AVIATION WEEK ARTIST'S conception of how Soviet nuclear-powered bomber prototype looks in three-view. Note bicycle main landing gear with outriggers folding up into wing from wingtip and tin high-speed airfoil. Nuclear powerplant air intakes are approximately 6-ft. in diameter. Radiation shielding details are not available, but divided shielding concept is used with heavy shielding around nuclear powerplants and additional shielding protecting crew compartments.

Soviets Flight Testing Nuclear Bomber

Atomic powerplants producing 70,000 lb. thrust are combined with turbojets for initial operations.

Washington—A nuclear-powered bomber is being flight tested in the Soviet Union.

Completed about six months ago, this aircraft has been flying in the Moscow area for at least two months. It has been observed both in flight and on the ground by a wide variety of foreign observers from Communist and non-Communist countries.

In its initial flight testing, the new aircraft is powered by a combination of nuclear and conventional turbojet engines. Two direct air cycle nuclear powerplants are housed in 36-ft.-long nacelles slung on short pylons about midway out on each wing. These nuclear powerplants, with 6-ft.-diameter air intakes and using small but high power reactors to replace the combustion chambers in the turbojet cycle, produce about 70,000 lb. thrust each.

They are supplemented by two conventional turbojets installed in wingtip pods fitted with short afterburners to provide about 35,000 lb. thrust each for takeoff performance. The conventional, chemically fueled turbojets are used primarily for safety purposes during the early flight test program of the nuclear powerplants. In later versions of the aircraft, they may be retained for high-speed dash performance or replaced by two more nuclear powerplants after their reliability has been proved in flight.

The Russian nuclear-powered bomber is not a flying test bed in the sense that earlier U. S. Air Force and Navy programs had called for installing a nuclear powerplant in a conventional airframe such as the B-36 or Saunders-Roe Princess flying boat solely for test purposes. The Soviet aircraft is prototype of a design to perform a military mission as a continuous airborne alert warning system and missile launching platform similar to the USAF CAMAL project for which Convair and Lockheed are now making design studies (AW Nov. 10, p. 37). The CAMAL mission was recently described in detail by Maj. Gen. Donald Keirn (see box page 28).

In its present configuration with both nuclear and conventional turbojets, the Soviet aircraft has a performance capability in the high subsonic and low supersonic speed ranges with its range limited only by engine component life and crew endurance.

The Soviet nuclear-powered plane has a fuselage about 195 ft. long and a 78 ft. wingspan. The delta-type wing is sweptback on both leading and trailing edges. From an initial angle of 60 deg. sweepback at the wing root, the leading edge changes to about 55 deg. sweep at the inboard engine pylon mounts and beyond to the wingtips to produce a "cranked" effect familiar on British bombers such as the Handley Page Victor and Avro Vulcan. Trailing edge of the wing is swept about 15 deg. This delta-type wing uses a relatively thin, high-speed airfoil confirming eventual performance goals for this design in the Mach 2 speed area.

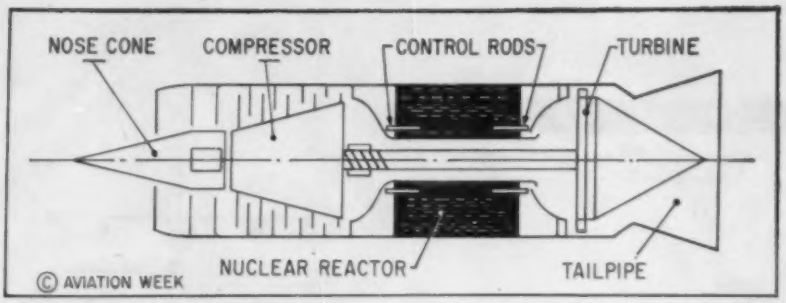
Vertical tail rises about 22 ft. above the fuselage. It is a typical "sail" type fin used by Soviet designers to ensure good directional stability. Horizontal tail surfaces have a span of 30 ft. and are swept back at about the same angle as the outboard wing panels. They apparently are kept well clear of the nuclear powerplant efflux both by placement high on the fuselage and by span length.

Aircraft has a gross weight of about 300,000 lb., and a wing loading of about 118 lb. per sq. ft.

The direct air cycle nuclear powerplant has been described in some detail in Soviet technical publications (see diagram on page 28). In a text published last year by the Military Press of the Soviet Defense Ministry entitled "Application of Atomic Engines in Aviation," the direct air cycle powerplant is described as follows:

"The simplest is a design that differs from the ordinary turbojet engine only in that the combustion chamber is replaced by a reactor . . .

"This simplest design permits obtaining the highest specific performance parameters. In this case, the air duct



SCHEMATIC DIAGRAMS from Soviet technical source on a direct air cycle atomic turbojet. Nuclear reactor is used in place of normal chemical fuel combustion chamber with air and compressor shaft passing directly through reactor.

becomes a uniflow duct where the airflow through the engine is at all times parallel to the engine axis in a straight line so that hydraulic resistance is at a minimum.

"The air is heated directly in the reactor without an intermediate heat transfer agent. This simplifies the design and eliminates excessive heat loss. However, this design which is simple in principle, is exceedingly difficult to realize. The shaft connecting the turbine with the compressor has to pass through the reactor. Cooling the shaft under these conditions becomes a difficult, and actually the key, problem.

"The point is that the shaft not only becomes heated as a result of heat transfer from the hot reactor parts but considerable liberation of heat occurs within the shaft itself due to scattering and absorption of neutrons and gamma rays by the shaft material. So much heat is liberated in the shaft that cooling of the shaft changes from a simple engineering matter to a complex problem whose solution will govern the very possibility of developing an atomic turbojet engine on the basis of this 'simplest' design."

This direct air cycle nuclear powerplant represents the same approach pursued by the Aircraft Nuclear Propulsion Department of General Electric Co. under USAF and Atomic Energy Commission sponsorship since 1951 at facilities in Evendale, Ohio, and Arco, Idaho.

D. R. Shoults, general manager of the GE nuclear propulsion program, reported that actual operational tests at the ARCO facility had "proved the feasibility of a direct air cycle aircraft propulsion system and demonstrated its performance." The Shoults report was made in a paper prepared for the Second United Nations International Conference on Peaceful Uses of Atomic Energy held last September in Geneva, Switzerland (AW Sept. 22, p. 55).

He described the results of operating heat transfer reactor experiment No. 1 (HTRE-1) during more than 100 hr. of turbojet running on nuclear power without "any failures of any sort".

Shoults also reported that HTRE-1 determined the following:

- **Integrated performance** of the reactor and turbojet engine in the powerplant system.
- **That overheating in portions of** the reactor would not lead to local flow starvation and progressive overheating.
- **Integrity and life of key** components of the system.
- **Ability to carry out extensive** remote handling of radioactive components.
- **Control response of the reactor** and its relationship to turbojet engine control.
- **Unanticipated problems and** their possible solutions.

The approach to flight testing nuclear-powered aircraft both in this country and in the Soviet Union calls for initial operations on conventional chemical fuels to prove out aircraft systems and familiarize the crew with operational techniques. However, even in operational use of a nuclear-powered military aircraft, nuclear powerplants may be operated initially on chemical fuel until the reactor temperatures are sufficiently high for full power operation. Then chemical fuel combustion can be phased out and the turbojet permitted to operate on nuclear power alone. Similarly, on return from a mission the reactors would be shut down some distance from destination, with the return to base and landing again made on chemical fuels. For this type of operation, a chemical combustion system also must be incorporated in the nuclear powerplant package.

Powerplants Flight Tested

Although much of the early flight testing of the Soviet nuclear aircraft has been conducted on conventional fuel the nuclear powerplants have definitely been tested in the air. Fission of one pound of uranium 235—most frequently mentioned in Soviet technical literature along with plutonium 239 as an airborne reactor fuel—will liberate about the same amount of energy as the burning of 1,700,000 lb. of gasoline.

There is no specific information available on the types of shielding employed on the new nuclear-powered aircraft but recent Soviet technical literature has been studded with brief but positive references to a major "breakthrough" in shielding techniques. Soviet technical literature emphasizes the concept of divided shielding with heavy use of stainless steel in the engine and aircraft structure to provide containment shielding for neutron radiation and another type of shielding protecting the crew quarters from gamma radiation. The extreme length of the aircraft fuselage also would be aimed at maximum separation of crew from the radioactive engines.

The podded installation is best suited

Nuclear Plane's Military Mission

Washington—"Imagine a fleet of 'enemy' high speed aircraft continuously patrolling the airspace just outside our early warning net capable of air launching a devastating missile attack against our hardened installations. Through a consideration of these capabilities, combined with those possessed by the intercontinental range ballistic missile, the degree of possible future threat of surprise attack immediately becomes apparent. . . .

"An ideal airborne alert manned aircraft system must carry a large payload and remain on nomadic patrol for extended periods of time in various areas of the world. It must maintain continuous communication with appropriate headquarters and be capable of instantaneous reaction with air launched missiles. When required, the system should be capable of following up the missile launching phase with a low-level high-speed penetration of the enemy's heartland in order to seek out and destroy hardened targets or targets whose locations are not sufficiently well known to permit attack by long-range missiles.

"The combination of these features can best be achieved through the application of nuclear propulsion. . . . Such a system may be similar in weight and size to the B-52 and be capable of carrying a heavy payload on extended endurance mission. Because of its endurance, varying armament load and high speed capability at minimum altitudes, its operational versatility would be outstanding. . . . But perhaps even more important is its inherent operational flexibility for meeting various limited war and peacetime situations."—Maj. Gen. Donald J. Keirn USAF deputy chief of staff for development for nuclear weapons.

U.S. Nuclear Powered Aircraft Program

• 1946—Nuclear Energy Propulsion for Aircraft program (NEPA) organized under Air Force contract with Fairchild Engine & Aircraft Co. project manager at Atomic Energy Commission's Oak Ridge, Tenn., laboratory. Purpose is to study feasibility of applying nuclear power to aircraft and develop components for such a system. Consultants from aircraft engine manufacturers and universities particpate.

• 1948—Lexington committee, primarily Massachusetts Institute of Technology professors, called in by AEC to study NEPA program. Recommend continuance of project.

• 1949—Oak Ridge AEC laboratory establishes nuclear aircraft propulsion research program.

• 1949—Technical Advisory Board reviews NEPA program, recommends continuance.

• 1950—Fairchild top management change and company is relieved of NEPA project.

• 1950—Divided shielding concept developed and NEPA project again approved by a review technical committee.

• 1951—USAF concludes NEPA had demonstrated feasibility of nuclear propulsion of aircraft.

• 1951—May, General Electric organizes aircraft nuclear propulsion program as part of its Aircraft Gas Turbine Division under USAF and AEC contract.

• 1951—May, Pratt & Whitney gets USAF contract to explore closed cycle nuclear powerplant.

• 1951—Fall, GE gets approval for development of direct air cycle type nuclear powerplant.

• 1952—Spring, GE begins work to develop experimental nuclear powerplant to be tested in B-36 with flight date projected for 1956. GE aircraft nuclear propulsion project becomes a separate department and begins work on six-day week.

• 1953—Spring, Convair makes first test aircraft equipment in radiation environment.

• 1953—May, Pratt & Whitney Aircraft gets AEC backup contract on USAF closed cycle work.

• 1953—Spring, Charles E. Wilson, Secretary of Defense, decides to cancel Convair-GE aircraft nuclear propulsion program. GE program retained by USAF Secretary Harold Talbott's diversion of unallocated funds to project.

• 1953—Fall, ground test reactor, first of its type outside AEC, designed and built by Convair and put into operation.

• 1954—USAF cancels B-36 nuclear engine test program. AEC continues support of GE program on limited scale. GE program with HTRE-1 goes back to system development with X-39 engine aimed at high-performance nuclear powerplant system to be operational in 1956.

• 1954—Fall, aircraft shielding test reactor, first flying reactor built and designed by Convair, put into operation.

• 1954—USAF develops WS-125A nuclear bomber program aimed at high subsonic cruise bomber with supersonic dash capability. Pratt & Whitney and General Electric are engine contractors and Convair and Lockheed airframe contractors.

• 1955—Navy begins nuclear-powered seaplane studies.

• 1955—September, first operation of a reactor in the air aboard a B-36 modified by Convair.

• 1955—October, engine-airframe company teams for system WS-125A selected by Air Force. GE and Convair as one team, Pratt & Whitney and Lockheed the other.

• 1956—January, GE successfully rates X39 turbojet engine with nuclear reactor in HTRE-1 for successful operation on nuclear power.

• 1956—Spring, USAF plans construction of 10 kilowatt test reactor for aircraft materiels testing at Wright Field, Ohio.

• 1956—September, National Advisory Committee for Aeronautics begins construction of nuclear test reactor at Lewis Flight Propulsion Laboratory, Cleveland.

• 1956—September to January, 1957, GE operates HTRE-1 with turbojet engine running 100 hr. on nuclear power without failure of any kind.

• 1956—Fall, USAF cancels WS-125A program. Powerplant development continued with no specific aircraft goals.

• 1957—May, Pratt & Whitney completes Connecticut Aircraft Nuclear Engineering Laboratory (CANEL) at Middletown, Conn., under AEC contract.

• 1957—June, Soviet Union ground tests nuclear aircraft powerplant system.

• 1957—August, USAF cancels Pratt & Whitney closed cycle engine development contract. CANEL cuts operations to greatly reduced scale. AEC continues support of P&WA program on small scale.

• 1957—Fall, General Electric proposes accelerated program aimed at getting flying test bed with nuclear powerplant into air as soon as possible.

• 1958—March, President Eisenhower informs Congress there is no urgency in nuclear aircraft propulsion program, rejects accelerated program and authorizes continued low budget development program.

• 1958—June, USAF proposes CAMAL nuclear-powered aircraft program to develop continuous airborne alert, missile launching and low-level penetration mission.

• 1958—July, Navy gets funds to conduct feasibility study of a nuclear-powered aircraft using Pratt & Whitney engines.

• 1958—August, first flights of Soviet nuclear-powered bomber prototype are observed in Moscow region.

• 1958—December, Air Research and Development Command scheduled to analyze Lockheed and Convair CAMAL design studies preliminary to possible award of prototype construction contract.

to the direct air cycle type nuclear powerplant since its operation makes the entire turbojet engine radioactive. The pod would facilitate engine removal by remote control for ground radiological safety and make replacement of the powerplants relatively simple.

Taking a nuclear-powered military aircraft from the early flight test stage, through which the Soviet aircraft is now passing, to a fully operational capability for both airborne early warning and missile launching capability probably will require at least 18-to-24 months. A nuclear powered aircraft requires extensive testing for other flight operational subsystems other than the powerplants and their operation under varying degrees and different types of radioactivity.

The current Soviet milestone in testing nuclear powerplants in flight in a military prototype is the result of a high-priority and financially well supported program stretching back through nearly eight years of research and development.

High priority for the nuclear aircraft program was assigned during the current Sixth five-year program which began in 1956 and will end in 1960. During the past few years, Soviet technical and popular publications began a steady crescendo in their coverage of atomic aircraft powerplant developments in addition to marine atomic powerplants for icebreakers, submarines and surface vessels.

This similar type of publication build-up has preceded every new major Soviet technical achievement, including the intercontinental ballistic missile and the Sputniks.

As long as a year ago, there were brief but specific mentions in the Soviet technical press of successful ground testing of atomic aircraft powerplants. Recent speculative stories in the Soviet popular press suggest conditioning the Russian people to an announcement of a spectacular achievement by an atomic-powered aircraft in the near future, probably a nonstop, non-refueled flight around the world.

F-108 Avionic Contract Awarded In Hotly Contested Competition

Washington—Hotly contested competition to select a contractor to develop the Mission & Traffic Control avionic subsystem for the F-108 Mach 3 interceptor was won last week by a team headed by the Federal Division of the International Telephone & Telegraph Corp. after Air Force rejected the first choice submitted by North American Aviation—Collins Radio Co.

In telegram received by at least two of five avionics manufacturers and teams that competed, North American said that procurement of this subsystem from International Telephone & Telegraph Corp. "would be to the best interest of the weapon system program."

North American's first choice for F-108 flight control subsystem contractor also has been disapproved by Wright Air Development Center, acting as technical adviser to Weapon System Project Office, and the matter has not yet been resolved.

The F-108 award also gives International Telephone & Telegraph (ITT) a possible edge in competition for the Mission & Traffic Control subsystem for North American's B-70 Mach 3 bomber.

Mission & Traffic Control, is similar to earlier communication-navigation-identification (CNI) package but also includes additional functions.

On the other hand, North American might recommend another contractor for the B-70, many of whose Mission & Traffic Control subsystem elements will be functionally similar to the F-108, in order to have a backstop for both programs.

Action of WADC in disapproving two of North American's F-108 selections focuses attention on a problem arising from source selection by weapon system managers that is causing some concern within the industry. Subsystem bidders supposedly are told not to submit their presentations to WADC Laboratories or other Air Force personnel while the weapon system manager is making his evaluation.

Adhered to Policy

One company, not involved in the F-108 program but bidding for a B-70 subsystem, says it has adhered to this policy and has not sought to advance its cause behind the scenes with WADC Laboratories, although it fears competitors may have done otherwise. If the F-108 establishes a pattern of the future, this spokesman says his company may be forced into behind-the-scenes efforts to match its competition efforts.

Maj. Gen. Victor R. Haugen, WADC director of systems management, told AVIATION WEEK Air Force policy on this subject has never been put in print, either to industry or to WADC Laboratories. He adds that it might be well to do so in order to clear the air.

WADC's Communication & Navigation Laboratory disapproved of North American's selection of Collins Radio Co. because of its desire "to make fullest use of Air Force sponsored developments and to achieve maximum standardization," according to two Air Force spokesmen.

Crux of Matter

Crux of the matter appears to be the high frequency (HF) data link system which Collins proposed to use. Hughes Aircraft Co. is developing a new HF voice and data link communication system under sponsorship of the Communication & Navigation Laboratory. The winning International Telephone & Telegraph proposal included use of the Hughes system. Collins proposed to use its own single sideband system developed under Rome Air Development Center sponsorship with an HF data link developed under Navy and Army sponsorship.

Collins declined to comment, apparently for fear of hurting its chances for the B-70 Mission & Traffic Control subsystem. It is known, however, that Collins has been primarily a Navy avionics supplier in the past and has had difficulty cracking the Air Force market for airborne communication and navigation equipment. Company is building the Communication-Navigation-Identification package for the Republic F-105, but this was sold directly to Republic Aviation. The Collins AN/ARC-58 airborne single sideband set was sold to Rome Air Development Center as part of an over-all package that included considerable ground equipment.

Air Force spokesmen say WADC made it clear to North American that the F-108 Mission & Traffic Control package should be compatible with the HF digital data-link system being developed by Hughes, which Air Force hopes to use on a variety of aircraft. One spokesman says the specifications North American sent out to bidders also made this point.

In any case, Collins chose to bid its own HF voice and data link system, which it apparently believed to be preferable to the one under development by Hughes.

When WADC vetoed the Collins selection, its engineers were invited to make a technical presentation to the Communication & Navigation Laboratory and Weapon System Project Office personnel to try and convince them of the superiority of the Collins approach. This failed, although an Air Force spokesman concedes that Collins had an uphill battle against an Air Force sponsored development.

A spokesman for WADC's Flight Control Laboratory says the question of using Air Force sponsored developments is not involved at all in its veto of North American's contractor choice. He points out that Flight Control Laboratory sponsors only a small fraction of the total development efforts carried out by industry and that it is eager to use the best techniques and ideas, regardless of where or how developed.

Navy Terminates P6M Program

Washington—Navy last week cut its order for Martin P6M Seamaster jet seaplanes from 24 to a total of 14 aircraft in one of the first concrete evidences of Administration plans for a tight Fiscal 1960 defense program.

A Martin Co. spokesman said the reduction in the Seamaster program probably will bring production of the aircraft to a halt within 10 to 11 months and force the company to lay off around 6,000 employes.

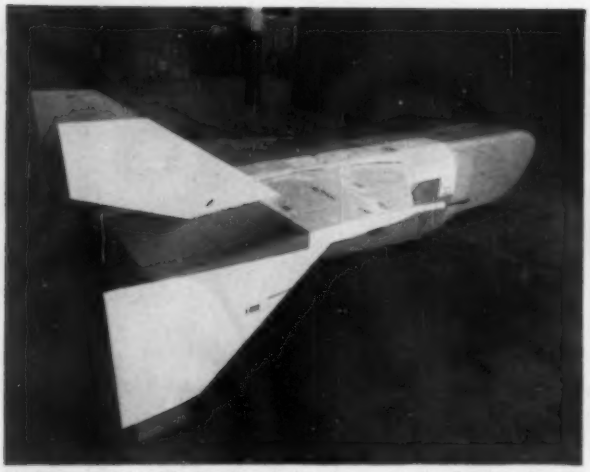
Present Navy development contracts do not include any other high-speed seaplanes. Virtual end of the Seamaster program also narrows the number of weapon delivery systems available to the U. S.

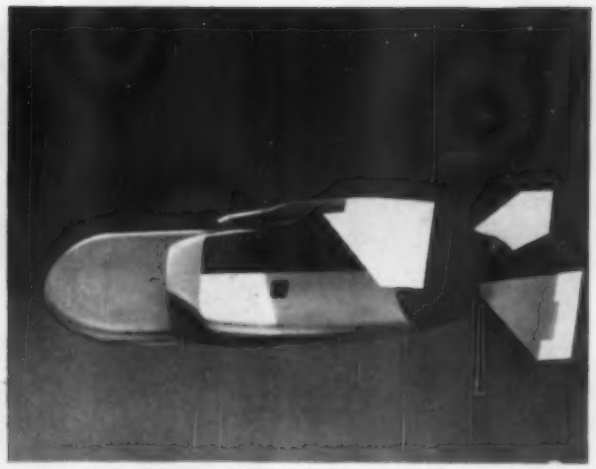
Concept behind the Seamaster was to have a large, long-range, transonic seaplane which would be capable of high-speed minelaying as well as bombing and could operate from floating bases in the open sea.

Six YP6M aircraft powered by four 10,000 lb. thrust Allison J71 turbojets have been delivered and eight P6M-2 Seamasters powered by 15,000 lb. thrust Pratt & Whitney J75s will be produced before the contract is terminated. These 14 aircraft will be operated together as a squadron.

The first six developmental aircraft cost $175,593,180; the last eight are covered under a $114,445,062 contract originally calling for 18 aircraft. This figure will be reduced somewhat in termination negotiations.

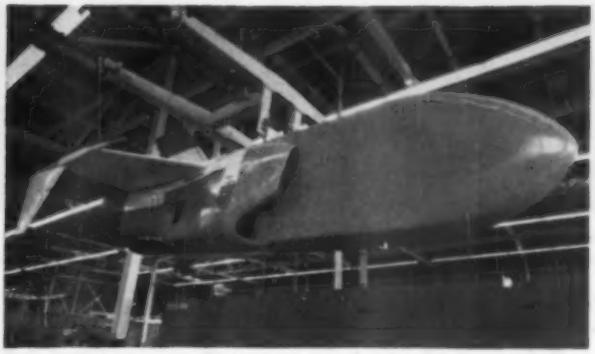
Two Seamasters were lost during its development program, the first with a loss of four lives. In the second crash, the crew of four left the aircraft safely during an inside loop at nearly maximum speed.



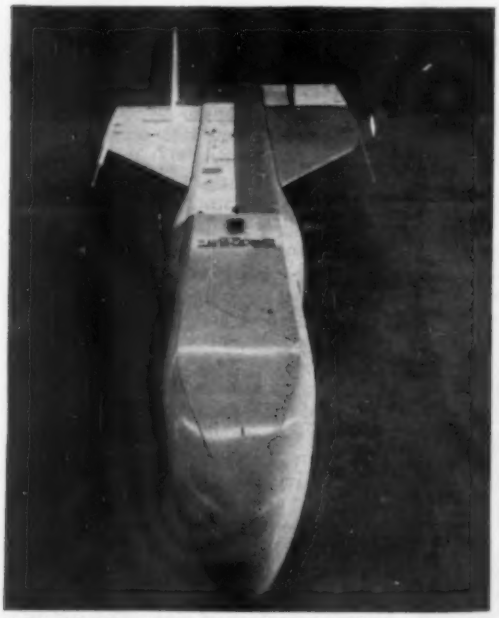


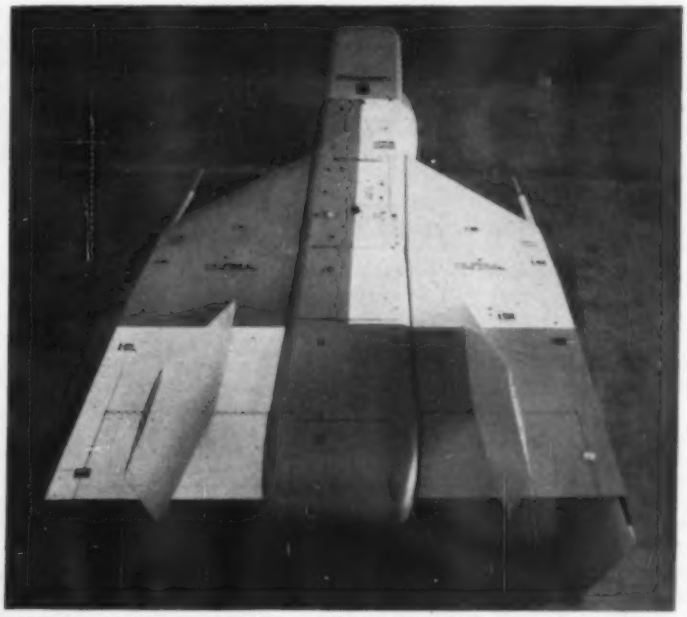
Air Force's GAM-72 Quail turbojet decoy missile developed and manufactured by McDonnell Aircraft Corp. has been launched from Boeing B-52 and B-47 bombers and recovered by parachute. Quail underwent captive and glide flight tests at Holloman AFB, N. M.

McDonnell Unveils Quail GAM-72 Decoy Missile

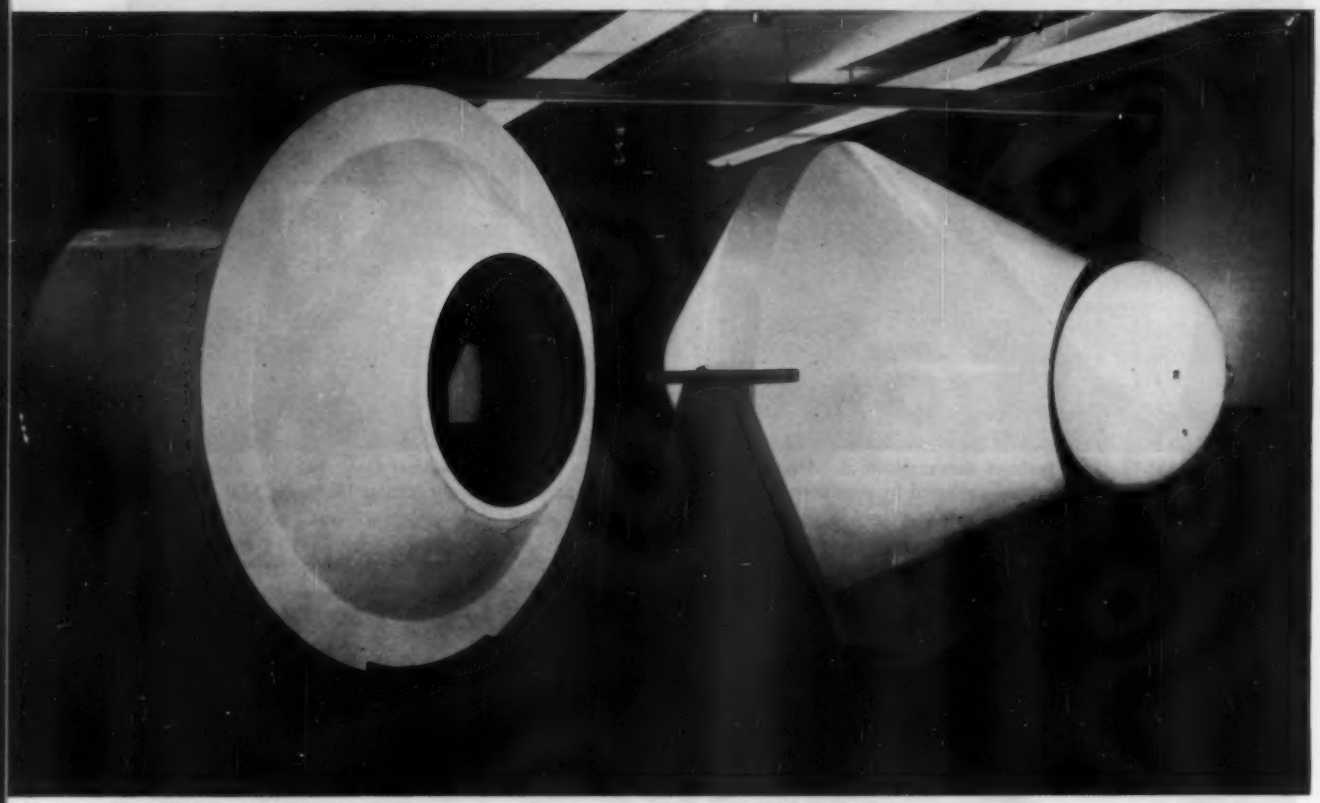


Quail's size is limited by the dimensions of the bomb bays in which it is designed to be carried. Upper vertical tail surfaces (left) are hinged to reduce height while in bomb bay. Spike antennas projecting from wing leading edge may be for electronic countermeasures.





Quail planform is shown in forward and aft views. Powerplant is missile version of General Electric J85; aircraft version is rated at 2,450 lb. thrust at sea level. Unusual engine air intake design may be to achieve optimum air ingestion during drop from bomb bay.



MOCKUPS of two GE capsule designs show similarities in configuration to GE's nose cones for ballistic missiles. Capsule at left is for two men. Mockup at right represents a GE approach to the NASA Man-in-Space program.

Space Technology

North American, GE Make Joint Manned

By Evert Clark

Washington—General Electric Co. and North American Aviation Inc.—competitors in a recent Air Force man-in-space capsule study—have teamed up in an effort to win the manned satellite competition now being held jointly by National Aeronautics and Space Administration and Advanced Research Projects Agency.

New details of General Electric's satellite design concepts were revealed by H. W. Paige, general manager of the company's Missile and Space Vehicle Division, in the Redding Lecture delivered at Franklin Institute.

These concepts grow out of GE's development of the Atlas and Thor nose cones; two years of study of manned versions of these re-entry bodies; experience with the radio system that guides the Atlas, which is the most likely launching vehicle for the NASA capsule; familiarity with recovery of nose cones at sea, and the Air Force Phase I capsule study, which was allowed to expire when NASA took over the man-in-space program.

Although NASA's specifications are quite detailed, and restrict contractors to a specific approach (AW Nov. 24, p. 28) that will differ from the studies made by many of the competing companies over recent months, many of GE's design parameters are close enough to the capsule NASA is seeking to be of interest.

Highlights of Plan

Highlights of GE's approach as detailed by Paige indicate that:

• **Launching from Cape Canaveral, Fla.,** probably will be to the northeast since this would put the first six or seven orbital cycles in the vicinity of the U.S. and considerably increase chances of a landing on or near the continent, "greatly facilitating the search and recovery problem." All missile launches have been to the southeast along the Atlantic Missile Range, but lunar probes and some satellites have been launched in more northerly directions. Southeasterly launch would give only two orbital paths in the vicinity of the U.S. early in the flight.

Although the northeasterly angle would require "new range facilities and re-orientation of missile guidance stations," Paige said it "may well be worth the expense."

• **Impact dispersions** can be held to less than 100 mi. and search sweep widths of more than 100 mi. are possible, giving "an extremely high probability of successful location of the capsule and its occupant within 24 hr. after return to earth." NASA's minimum time requirement for the capsule to stay afloat is 12 hr.

Fleet of ships and planes would be used for search and location. Although this is a more ambitious undertaking than that used for nose cone recovery, Paige said "the design approach taken will be one to emphasize man's safety."

Problems of location and recovery "are well in hand," he said. "We have repeatedly performed successful flight data recoveries with our (Atlas and Thor) data recovery capsule."

• **Stringent preflight program** of qualification and reliability testing will precede launching of man. This will include drop tests, impact tests, environmental tests, etc., and will "be more

CONSOLE of variable drag capsule mockup is demonstrated to Maj. Gen. Ben I. Funk, USAF deputy director-ballistic missiles, AMC. Seat is contour-molded to pilot, adjusts to supine position (right). Note Maj. Gen. Funk's hand on control lever (left).

Satellite Bid

stringent than on any program of the past or present."

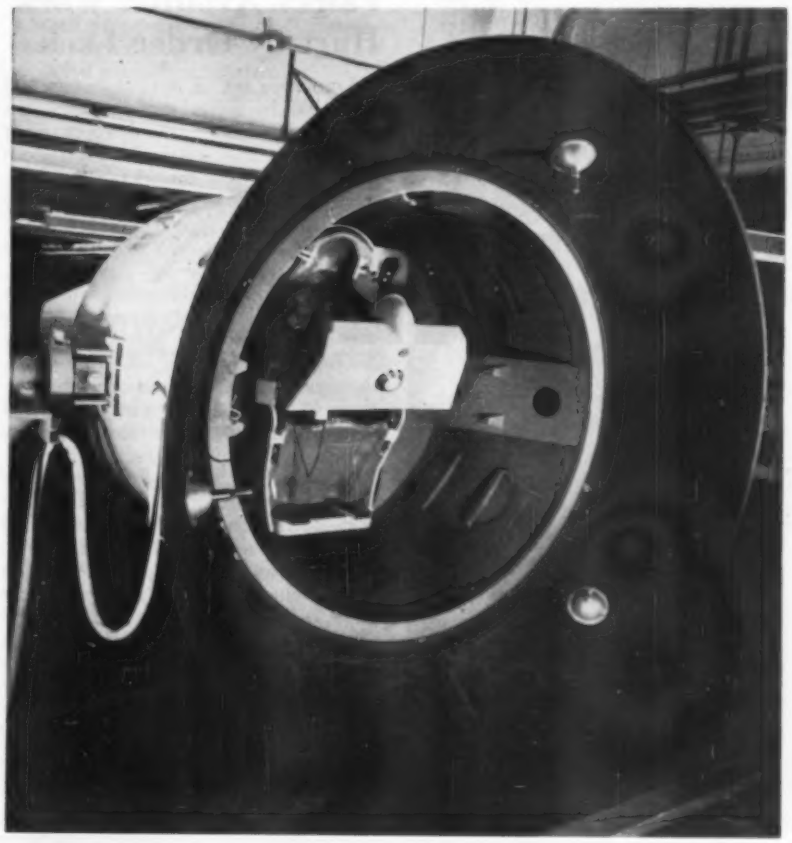
• **First flights probably** will be ballistic trajectories short of orbit and carrying animals to prove out the system. First orbital flights will be with complete, but unmanned, systems.

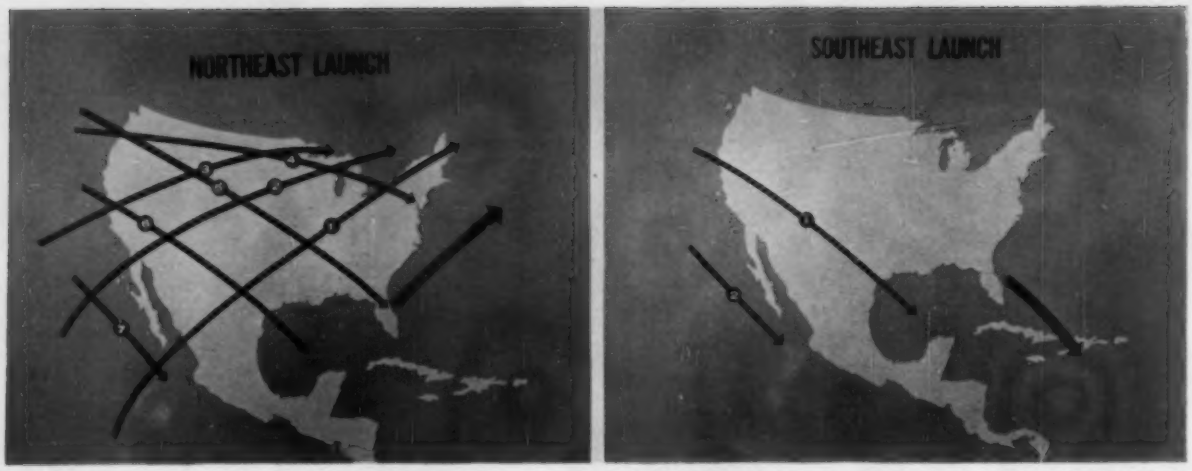
• **Pure ballistic, high-drag shape** has been chosen because it offers the highest reliability and safety, since there is not yet any assurance that a pilot can control glide or variable drag vehicles in space and on re-entry. Later vehicles will be glide or variable drag shapes, because they offer maneuverability. High-drag ballistic shape also offers the fastest approach from the standpoint of hardware development.

Pure ballistic design has the disadvantage of higher accelerations on both re-entry and emergency escape during launch, but the gravity loadings are within tolerable limits if re-entry angle is proper. Angle of 2.8 deg., for example, limits acceleration to just above 12G.

Severe design condition comes from the need to shield the occupant from hearing. For a three degree angle, for

OVER-ALL view shows variable drag capsule mockup under study by GE.





MAPS compare number of early flight orbits across U.S. with a northeast launch (left) and a southeast launch (right). Northeast launch would require radical reorientation of tracking facilities and added expense, but enhanced recovery opportunities are proposed as justifying the cost. Both use Cape Canaveral, Fla., as the launching site.

instance, total heating at the nose of one GE design is 7,500 Btu/sq. ft., and peak rate of heating was 100 Btu/sq. ft./sec.

General Electric studies favored firing a retrorocket downward and backward from the direction of flight to get the satellite out of its 100-125 mi. circular orbit and onto a re-entry trajectory.

Imparted velocity of this rocket and the proper firing angle are of fundamental importance, Paige said, since they influence range from the time of firing to time of impact, and dispersion of the impact.

Larger retrorocket decreases dispersion and range, but increases peak G-load. The 12G peak which is currently considered "to be uncomfortable but tolerable" on a well-supported man limits imparted velocity to 1,500 fps. This imparted velocity plus the proper firing angle would give a range to impact of 2,000 naut. mi. and a dispersion about the intended impact point of about 75 mi.

CUTAWAY of GE two-man capsule mockup shows seating arrangement of interior. This is the re-entry face of the capsule and the occupants have their backs to it.

Design competition in which North American and GE engaged was for a "life-support system," and was aimed at determining survival factors, such as tolerable G-loads, air and food requirements, etc. Each company received in the neighborhood of a quarter of a million dollars on contract, and provided considerable funds of its own. Basic information from the Air Force studies has been made available to NASA.

Fairey Aviation Work Hurt by Order Lack

London—Lack of aircraft orders and the need to spend more on research and development without government support has hurt Fairey Aviation Co.'s financial position considerably, Chairman and Managing Director Geoffrey Hall said in his annual report.

Subsidiary companies in Canada and Australia are showing good results, Hall said, and diversification into other industries, including nuclear power, marine engineering, plastics and air photography is paying off. But unless more aircraft work is forthcoming—especially from the government—Fairey will be forced to close down some plants, he added.

Some of the company's projects have finished due entirely to lack of interest and orders from the government, Hall noted. These include the Fireflash missile and the Delta-2 aircraft. Work in hand includes design and development of an anti-tank missile for the army and an order for one Rotodyne VTOL. Company also hopes to receive a Canadian order for its Ultra Light helicopter, he said.

Referring to the Rotodyne project, Hall said the company had spent $1.5 million on its development in the last year, and was setting aside a similar amount for general research and development this year.

Although Ministry of Supply has approved Rotodyne, Hall said, negotiations for government backing have been protracted and "we cannot, after this long delay be entirely hopeful as to the outcome."

Unless the government provides some financing soon, "outside" backing will be necessary followed by manufacture of the Rotodyne in another country, he added. Kaman Aircraft Corp. is U.S. licensee.

Fairey declines to say how much it has asked from the government for the venture but industry observers estimate the company would sink $5.5 million in it if the government would contribute $14 million.

Nozzles Formed By Plasma Arc Heating

New York—Plasma arc temperatures to 15,000 deg. Kelvin are being utilized to fabricate solid propellant rocket nozzles and Jetevators, and to coat experimental nose cones with tungsten and other refractory materials. Developer of the process is the Linde Co., Speedway, Ind., a division of Union Carbide Corp.

In addition to high temperature missile applications, the plasma arc processes are said to have utility in the electronics field in forming tungsten grids and other cathode ray tube components. The company claims that tungsten, molybdenum, zirconium, tantalum, platinum and other metals can be fabricated to any desired thickness to tolerances of ±002 in.

Bid Reopening

Washington—Reopening of bidding on a one million lb. thrust, single-chamber rocket engine mentioned recently by Advanced Research Projects Agency Director Roy Johnson (AW Nov. 24, p. 26), apparently applies to building of the first engine.

Rocketdyne Division of North American Aviation Inc. is continuing to design the engine but reopening the bidding by National Aeronautics and Space Administration could mean another developer would be picked for prototype.

Possibility that a reshaping of space programs under White House and NASA supervision will lead to cancellation of the only other announced booster in the million-lb. area still exists. This is the cluster of eight Jupiter rocket engines being studied by Army Ballistic Missile Agency and Rocketdyne. If ABMA's space work is put under the jurisdiction of NASA, Navaho boosters might be substituted for the Jupiter cluster. Three-barreled Navaho booster capable of developing well over 400,000 lb. thrust also could be clustered.

Aircraft, Avionic Assns. Begin Wage Dispute

Washington—Aircraft and electronic industry associations began a legal controversy over minimum wages here last week which will force the Labor Department to rule whether electronic manufacturers are part of the aviation industry.

Under present regulations, minimum wages paid by electronic companies doing defense business are about $1.60 per hour or around approximately 30 cents lower than the legal minimum in the aircraft industry. Aircraft firms contend that this minimum wage differential places them at a disadvantage when bidding against avionic firms for guidance system contracts and other automatic and semi-automatic equipment relating directly to aircraft and missiles.

Aircraft Industries Assn. has asked that the Secretary of Labor use his authority to set minimum wages for government contractors granted him under the Walsh-Healey Act and to fix a uniform scale for virtually all companies engaged in aircraft and missile work.

Electrical accessories such as magnetos and sparkplugs are not included in the petition but guidance, navigation, control systems and related equipment are.

The aircraft industry's two biggest unions, the International Assn. of Machinists and the United Automobile Workers, also have submitted similar petitions to the Labor Department.

Electronic Industries Assn. has countered with a proposal that the present ruling for the aircraft industry, established in 1950 by the Secretary of Labor, be continued.

Major fear of the electronic industry is that a sudden 30 cent per hour increase in minimum wages on government contracts would bring overwhelming pressure for wage increases in its commercial work.

ARDC and Industry Study Space Designs

Washington—Studies of seven general types of military space systems are being conducted by industry and Air Force's Air Research and Development Command.

Except for work already underway, such as space probes and the Dyna-Soar orbital bomber studies, ARDC currently is limited in its military space work primarily to studies in support of Advanced Research Projects Agency or National Aeronautics and Space Administration missions. Work ordinarily does not progress as far as weapon system design studies without approval by one or both of those agencies.

Space systems areas now under study in the joint industry-ARDC approach—some funded by ARDC, some by industry alone and some jointly—are the following:

- **Strategic orbital system** for operation near the earth.
- **Global surveillance system.**
- **Twenty-four-hr.** reconnaissance satellite.
- **Strategic lunar system** for operation in the moon's area, probably in a lunar orbit.
- **Lunar observatory.**
- **Strategic interplanetary system.**
- **Satellite interceptor.**

News Digest

Turboprop-powered early warning aircraft, designated W2F-1 is being developed for U.S. Navy by Grumman Aircraft at Bethpage, N. Y. The aircraft will be a replacement for the Grumman WF-2 Tracer and will be powered by two Allison turboprop engines. W2F-1 will operate from carriers and will have considerably more range than the Tracer. Detection gear will be housed in saucer-shaped radome atop the fuselage.

Novel parachute, with four sail-like separate cloth sections that spin like a helicopter rotor, has been developed by Pioneer Parachute Co. Vortex ring chute, designed for accurate air-drop of materiel and also as braking aid for jet planes, is being evaluated by armed services and two aircraft manufacturers.

American Machine & Foundry Co. has been awarded a $29,300,000 contract by Ballistic Missile Division of Air Research and Development Command for design and development of Titan intercontinental ballistic missile underground launching system (AW Sept. 15, p. 29).

Arsenal concept was criticized by Ernest R. Breech, chairman of the Ford Motor Co., at the annual Wings Club dinner in New York last week. Workable for simple weapons as rifles or ammunition, the arsenal concept applied to more complex weapon systems could lead to technical stagnation, prolonged development delay and inefficiency, Breech said.

Grumman Aircraft has formed a space projects "task force" of top design engineers and research scientists brought together to study problems connected with space and its exploration.

British Navy has grounded Scimitar interceptor following a crash during a routine training flight. Pilot was ejected but received fatal injuries.

Capital Airlines last week announced plans to lease three Viscount 812 turboprop transports from Continental Air Lines for use in scheduled service beginning Dec. 14, confirming an AVIATION WEEK report of last May 12 (p. 45). Capital will operate the three aircraft on its New York-Chicago and Washington-Chicago routes. Lease contract will run from Nov. 28 to April 25, with an option to renew at that time. Aircraft configuration includes 52 seats and a four-seat lounge. Capital's name will be painted on the top-side of the fuselage but the plane will continue to carry Continental's insignia.

Thiokol Subroc Award

Navy has awarded Thiokol Chemical Corp. a research and development contract for main propulsion system of Subroc despite reported preference of prime contractor, Goodyear Aircraft Corp., for another propellant manufacturer. Award was made to Thiokol principally because of work on high energy solid propellants underway at company's Elkton, Md., plant. Subroc propulsion unit is expected to be a high energy solid propellant rocket designed to conform to long, thin configuration of missile which will be fired through torpedo tubes.

Airline Strikes Portend Series of Battles

Third-crewman issue gets first showdown in Eastern strike as labor troubles plague airline industry.

By Glenn Garrison

New York—Airline management and labor squared off last week in what threatened to be a series of battles over stalled and strike-ridden jet age contract negotiations.

Eastern Air Lines, struck by its flight engineers last week in the first industry showdown on the third crewman issue, and also hit by a mechanics' walkout the same day, was digging in for the long pull. It canceled its Dec. 1 inaugural of Lockheed Electra service and was investigating ways and means for possible slowdown of additional Electra deliveries, suspension of construction projects and halting deliveries of various supplies.

A strike threat by National Airlines mechanics evaporated as the carrier and the union signed a new contract including pay raises totaling 44 cents over the three-year term of the agreement.

Trans World Airlines system was still shut down at mid-week as a result of an International Assn. of Machinists strike Nov. 21 against the airline over wages. A federal mediator was in Kansas City trying to find some solution to the impasse, and through him the union made a new offer.

Neither Eastern nor its engineers showed signs last week of softening their positions on the crewman issue, which was brought to a head by agreement between the airline and its pilots that flight engineers be pilot-qualified. The flight engineers believe that if they hold out for 15 days, they will have Eastern in a position where it will have to give in. If it doesn't, the engineers are prepared to go on as long as may be necessary, a spokesman indicated.

Eastern's decision on the issue followed recommendations of a Presidential Emergency Board.

This issue poses a major threat to industry labor relations, because there is apparently no solution that can reconcile the pilots' and engineers' positions. Unlike the mechanics' contract disputes over money, there appears to be little basis for negotiation.

Eastern and the engineers went to court over the matter last week. The airline seeks an injunction and also damages of $5 million plus $1 million for every day the strike continues; the engineers seek to invalidate the Eastern agreement with its pilots.

The crewman issue also brought American Airlines last week to the brink of a pilot strike, averted by a restraining order American got from a federal court. Hearing on the airline's petition for a permanent injunction was scheduled to be held last Friday.

Eastern's mechanics struck within an hour of its engineers, but the mechanics denied any cooperation even in the timing of the move. Eastern chapters of IAM, Flight Engineers International Assn. and Air Line Stewards and Stewardesses Assn. have formed a council to aid each other in disputes with management, but the mechanic's strike was over issues between their own union and Eastern, i.e., wages. The stewards and stewardesses, the airline said, were prepared to observe the picket lines of the other unions.

The Eastern council of the three unions was under consideration earlier this month as a model for an industry-wide organization. The legislative subcommittee of the AFL-CIO parent union called a meeting in Washington which was attended by representatives of the Transport Workers Union, Brotherhood of Railroad Clerks, the air line pilots, flight engineers and mechanics, representing a total of 80,000 airline workers.

The meeting was a counter-move to the six-airline pact between American, Eastern, Capital Airlines, United Air Lines, Pan American World Airways, and TWA, instituted several weeks ago. This agreement calls for payment to any of these lines shut down by strikes of revenues the others earn from

Viscount Displayed Behind Iron Curtain

Vickers Viscount, carrying Continental Airlines markings, last month made static and flight displays for about 150 Polish government and airline officials at Warsaw Airport, confirming Aviation Week forecast that a western manufacturer would attempt a sales penetration behind the Iron Curtain (AW Sept. 8, p. 47). Viscount 812, one of 13 being built for Continental, took a number of LOT Polish Airline officials on familiarization flights. Vickers-Armstrongs sales effort is in competition with Russia, which has been campaigning to get its turboprop and turbojet transports into service outside the USSR.

diverted business. It was evoked in the 37-day Capital mechanics strike which ended after a wage agreement (AW Nov. 24, p. 37) and is a feature of the current strikes. Its legality, however, has not been established.

Two local service carriers also were having strike problems last week. Stewardesses of Lake Central Airlines went out, but the airline continues full operation. West Coast Airlines mechanics set a strike deadline during the week but the dispute was settled without grounding the company's aircraft.

Lake Central's stewardesses are members of ALSSA, which is a subsidiary of the airline pilot's union. The pilots crossed picket lines, but the two unions were meeting last week to try and work out a solution which could be offered to Lake Central management.

The striking mechanics are prepared for a long battle if necessary, but their situation varies on the local level. Dissidence has been reported between groups within these locals. In the case of Capital Airlines, the negotiating committee of the IAM local asked A. J. Hayes, president of the international union, to take over negotiations. Hayes and Capital president David Baker personally conducted the negotiations which led to the strike's end.

Complete unanimity does not exist among airline managements despite the mutual aid pacts. A number of airline executives, for example, have privately criticized Northwest Airlines for agreeing to a 41 cents increase with its local IAM chapter at a time when Capital was holding out in the thick of a strike for 38 cents. Final Capital settlement matched the Northwest figure.

American's pilots cite four major issues in their strike decision, but the airline calls the crewman question the "key issue" in the situation. Others are money, rules governing working time, off time, and scheduling, according to the pilots.

American, however, is basing its injunction plea on the argument that Railway Labor Act procedures have not been exhausted in mediating the dispute and hence a strike would be illegal. The airline contends there has been no real bargaining yet on the contested issues.

One solution to the third man issue that has been proposed by ALPA to several airlines is to provide a fourth man in the cockpit. The pilot's union doesn't mind the presence of a mechanic-qualified engineer as long as there is a third pilot among the crew. This would satisfy the pilot's demand, made in the name of safety, that three men capable of handling the controls be on duty in jet cockpits.

It seems unlikely, however, that the idea of carrying a fourth crewman along for the ride would have the effect of attracting much airline support.

American and ALPA prepared for a meeting which had been scheduled for last Wednesday, and results were to have been reported at the hearing on Friday. The airline said the strike notification, which carried a Nov. 25 deadline, had arrived unexpected Nov. 22 and had "caught us off base."

Pan American, meanwhile, was going ahead with its transatlantic jet services flown by supervisory pilots. The carrier last week was continuing contract negotiations with Transport Workers Union, which represents PanAm's mechanics. The contract expired today. PanAm's pilot contract runs through Dec. 31, 1958.

The Independent Airlines Assn. last week said 20 supplemental carriers could offer 3,600 seats a day to ease the traffic situation brought about by the strikes. Four-fifths of the association members' fleets are four-engined aircraft suitable for long haul business, the association said.

At midweek, National and Northeast Airlines reported a rush of bookings but each said it could provide all the seats needed to handle grounded Eastern passengers. Northeast noted that the situation had arisen at a time when the carrier's fleet was geared for peak season and it could cope with the extra load on New England routes as well as the Florida run.

National was adding sections, had doubled its switchboard staff and said it could take care of Eastern's entire demand. Publicity regarding the strikes and rumors of others, including National, has caused diversion of some business to surface transportation, National said.

United Air Lines reported it was swamped with holiday bookings. In addition to what it would normally get of TWA's diverted traffic, passengers alerted to the possibility of the American strike were calling United for space that seemed surer.

Pan American reported little effect on its traffic from the TWA strike. No extra sections have been added and total diversion was estimated at less than 100 passengers by last Tuesday.

Eastern had scheduled the introduction of its Electra turboprops for today. Aircraft were to go into service initially between New York and Miami, New York-Houston-San Antonio, New York-Atlanta-Tampa, Montreal-New York-Miami, and Montreal-Newark-Washington.

The airline had received six Electra's before the grounding. A total of 12 were to have been delivered by the end of 1958, the remaining 22 during 1959.

Hector Disputes CAB Ruling Denying TWA Siesta Seat Plan

Washington—Civil Aeronautics Board denial of Trans World Airlines transcontinental Siesta Sleeper Seat Service drew a scathing 37-page dissent last week from Board member Louis J. Hector.

Hector criticized the action of his colleagues as denying improved service to the traveling public and denying airlines the freedom to manage their own affairs "within the free play of the competitive market."

"It is odd," Hector said in his dissent in the formal ruling in the case, "that this Board should deny the American domestic air passenger a service which is provided at no extra charge in many foreign countries and on many international runs, including indeed the runs of some foreign carriers across the United States."

Major grounds for the denial, as expressed by the other four members of the Board, were that TWA's additional service at regular first-class fares was "unjust and unreasonable" and might break down fare regulations between different classes of service since both American and United indicated the possibility of inaugurating a similar competitive measure.

Opposition to the TWA service was originally filed with CAB by American.

The Board, however, emphasized that its order does not prohibit TWA from offering the extra service if it places a surcharge on the "luxury" service, which the Board estimated should be 20% higher than the present one-way, first-class transcontinental fares.

Board members had originally announced their tentative vote late June after rejecting recommendations favoring TWA by CAB examiner Richard A. Walsh. American Airlines recently prodded the Board for its delay in announcing its formal decision (AW Nov. 10, p. 25).

Recalling the examiner's favorable recommendation of April 3, and the immediate exceptions filed by American and United airlines, Hector called attention to a tariff filing by American on April 23. If approved by the CAB, this tariff would have permitted American to charge coach fares on Douglas DC-7 aircraft with first-class seating configurations on nonstop transcontinental flights departing at off-peak hours.

"To anyone who believes in the virtues of the competitive system, this seemed a very healthy development."

Hector said. "Two large carriers competing vigorously for an important segment of traffic were each giving the customer more for his money in an effort to gain a larger share of the market . . . in precisely the same way that producers of consumer goods and services . . . both essential and luxury . . . have throughout our economic history done a better and better job for the American consumer under the spur of competition.

"This seemed a healthy development also in view of the fact that one of the crucial problems for the all airlines in the next decade is to increase traffic substantially and that this can probably be accomplished only by lower fares and improved service.

"Apparently frightened that genuine competition might break out," Hector continued, a majority of the Board then suspended the American tariff before it could go into effect and shortly after announced by press release their disapproval of the TWA Siesta Sleeper Seat.

Hector also observed that Trans World Airlines had instituted its Siesta Sleeper Seat Service as a means of meeting its competitor's speed advantage with DC-7 aircraft.

Eastern Asks Tighter Florida Competition

Washington—Eastern Airlines, continuing its fight against the Pan American-National Airlines stock exchange and equipment lease proposal (AW Sept. 22, p. 38) has asked Civil Aeronautics Board to investigate the possibility of eliminating Northeast Airlines as a third competitor in the New York-Florida market.

Contending that the issues of its request are directly interrelated with the Board's present investigation of the joint airline proposal, Eastern also requested CAB to consolidate both proposals for a hearing and decision on grounds that National's desire to carry out its agreement with Pan American is allegedly based upon the revenue impact of Northeast as a third carrier in the market.

Recalling Northeast's victory in the New York-Florida Case more than two years ago, Eastern attorneys allege that G. T. Baker, president of National, has said that, should the CAB award the route to Northeast, National would then "sell out" to Pan American since neither National nor Eastern could operate successfully between New York and Miami with third carrier competition. Baker could not be reached last week to reply to the Eastern statement, and other National officials declined to comment.

Three-carrier competition in the "allegedly foremost travel market in the country" has produced only economic disaster, Eastern said, pointing to a Northeast request for $4 million in subsidy (see box) as partial proof that the CAB had erred in its decision. The airline further emphasized that the Board granted the authority to Northeast in the belief that it would "eliminate the carrier's (then) current subsidy need of $1.5 million annually."

As a result of the extra competition, the Eastern attorneys said, load factors on the New York-Miami route for both Eastern and National have experienced a considerable drop, with Eastern's profits in the market becoming "marginal and disappearing."

Continued operation of Northeast on the route "simply prolongs the agony of Northeast, of National, of Eastern and the taxpayer," Eastern attorneys told the Board.

"There is no reason in law or on policy or equity why the agony should unnecessarily be prolonged," they added.

Northeast spokesmen also declined to comment on the Eastern request.

Delta Airlines, meanwhile, has suggested to CAB that, if Northeast is eliminated from the Florida market some other carrier "such as Delta" should be awarded the vacated New York-Florida authority.

Northeast Subsidy

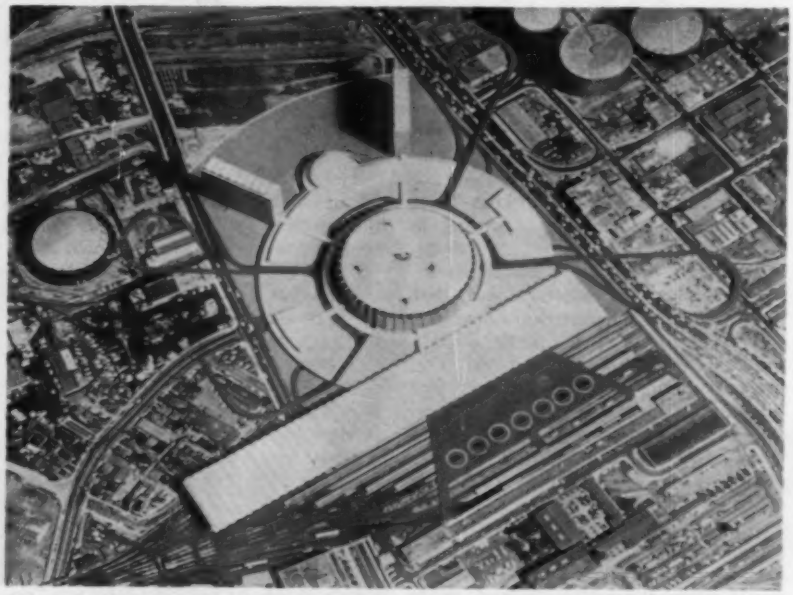
Washington—Civil Aeronautics Board last week voted to award $4.6 million in subsidy payments to Northeast Airlines as requested by the carrier on Sept. 15 (AW Sept. 22, p. 38).

Announcing its decision in a formal show-cause order, the Board said the increased temporary mail rate was being established "in view of the carrier's urgent need for additional working capital" and the impossibility of establishing a final rate in time to meet Northeast's need. Application of the subsidy payments will apply solely to Northeast's route system held prior to its New York-Florida route award, on which it began service approximately one year ago, and will cover the period from Feb. 7, 1957, to Dec. 31, 1958. Board members added that they expect to establish a final rate for the carrier by Jan. 1.

Financing Holds Up Los Angeles Terminal

Los Angeles—Plans for a proposed jet-age airline terminal here are being reappraised because of unexpected financial problems. Prior to the present financial crisis, work was being pushed to meet the goal set by the Board of Airport Commissioners for completion of the airport by Jan. 1, 1960 (AW Dec. 2, 1957, p. 41).

Presidential veto of the Federal Airport Aid Act is one factor behind present money problems. Los Angeles Department of Airports had expected to



PROPOSED transport center for downtown Los Angeles, Calif., features six-story circular terminal building with heliport on the roof. Long building in foreground is a shed station for a rapid transit line. Auxiliary buildings (top) feed into main terminal. Design was prepared by Albert C. Martin & Associates architectural firm from a conception developed by Kenneth Hahn, member of the Los Angeles County Board of Supervisors. Total cost is expected to be about $20 million.

receive approximately $9 million in matching funds for the planned airport development program. If the bill is passed during the next congressional session, it is expected that funds will be restored on a gate-to-gate basis, meaning that funds will be available for runways and taxiways only.

Under a proposition in the 1956 airport bond issue, airport income is forbidden for use for capital expenditures until 1970. Therefore, all airport capital expenditures for the next 12 years must be taken from the bond issue. This presents another financial drain, since money for items not included in the bond issue should be provided for necessary expansion prior to that date.

Money already expended for completed projects totaled $510,140. Work in progress will cost $4,331,357, and items which may have to be considered later could cost $5,872,909, for a total of $10,714,406.

Increased demands for airline space in the new terminal is the third drain on funds. About 40% more space than originally planned in the airline's estimate of space requirements at the time of the bond issue is now believed necessary.

These drains on funds required the Airport Commission to reappraise the building program to determine what was most needed and what could be postponed. The following projects amounting to $8.1 million have been postponed:

- **International's complex** of satellite buildings.
- **Mezzanine areas.**
- **Landscaping.**
- **Second floor ticketing** building No. 5.
- **Central plaza and bridges.**
- **Central shopping area.**

Projects that have progressed, and their present state, are:

- **Runway 25L** has been extended to 10,000 ft. and can be used for jet airliners by late January.
- **Reconstruction on Runway 25R** is 45% complete.
- **Lincoln bypass is 25%** complete.
- **Foundations are in for** the tower and administration complex and work is about 7% complete.
- **High-power lines have** been put underground at the end of new takeoff runway.
- **Plans for construction of** the Pershing Boulevard extension through the airport are completed and in the hands of the Board of Public Works.

Los Angeles airport commissioners hope that the Airport Aid Act will be passed by the coming session of Congress and signed by the President, although funds are expected to be reduced to between $3 million and $4 million below this year's request and will be on the gate-to-gate basis.

'Indefinite Ceiling'

Bangor, Me.—For the past several hours I have been witness to a remarkable performance. From the control tower of Dow AFB, I have been watching landings and takeoffs by such aircraft as the F-104, F3H and B-52. More correctly, I have been listening to these aircraft land and take off via GCA for the Dow weather is "indefinite ceiling 100 ft., visibility variable zero to one-half mile." This is mighty poor pickin's for operating some of the fastest and most modern aircraft in the world.

As reported here previously (AW Nov. 3, p. 43), the Strategic Air Command—in cooperation with other military units, government and civilian groups—is conducting this visual aid program to determine the adequacy of narrow gage, flush runway lights. USAF alone has programmed 432 landings on the system, 132 of which will be in visibilities below one-half mile. Added to this will be operations by the Navy, Airways Modernization Board, Canadian Department of Transport, various airlines and other civilian groups. Thus, the system will be flown by representatives with all classes of aircraft: cargo/transport, Navy carrier, fighter, Century Series interceptor, civil passenger, etc.

The weather began to get real good for this work around 9 p. m.—that is, the weather began to get real bad. I remained in the tower until about midnight, then left with Project Officer Lt. Col. Roy Strong for a tour of the runway (due to reports of poor braking conditions) and for a chat with the pilots. Throughout the entire evening, I was particularly impressed that SAC isn't kidding on this project. Col. Strong appears determined to run the best test program in the world, and the pilots on the project are just as eager to "get out and go" in bad weather.

Most of the fighter-type aircraft have a rather tricky fuel problem. Due to landing weight restrictions, some can be dispatched with only about 45 min. fuel on board. This allows one pass at the runway and, if landing is not accomplished, a quick trip to the alternate—in this case Plattsburg, N. Y. If all goes well, the plane can land at this alternate with as much as 100 gal. remaining.

Approaches are accomplished by use of GCA; the ILS is not yet commissioned. This, however, does not tell the whole story. In an effort to prove the runway lights, two little extras are thrown in: (1.) GCA issues advisories only until the pilot is over the "decision bar"—the 1,000 ft. bar on the approach lights—at which point the pilot is told to "Take over and land visually or pull up." (2.) By a switching arrangement in the tower, various configurations of runway lighting are turned on for each approach. Therefore, the pilot is definitely on his own for the last few seconds of flight and must land with whatever configuration happens to be in view.

From talks with several pilots in this first test group, it appears that the narrow gage system should not be shorter than 3,000 ft. for the faster aircraft. Pilots also indicated a need for a lighted centerline commencing where the narrow gage stops since most aircraft are still moving at or above 100 kt. at this point and additional steering guidance is required. Incidentally, the feeling persists with this author that, although the fighter pilots are doing a wonderful job, the single seat aircraft is greatly handicapped in all-weather work when the pilot is required to fly and look for the lights at the same time. The use of some sort of automatic pilot, preferably coupled to an ILS, appears to be a requirement for very bad weather.

While it is still early to draw conclusions from Dow Field, the system is capable of landing aircraft in greatly reduced visibility. Undoubtedly many things will be learned at Dow this winter, and the final results should identify the optimum narrow gage configuration with incontestible proof. This will be a tremendous step forward for aviation.

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FLY THE FINEST... FLY **TWA** TRANS WORLD AIRLINES

Air India May Get Beyond-Moscow Rights

By L. L. Doty

New Delhi—Bilateral air transport pact between the Soviet Union and India opens the way for carriage of traffic beyond Moscow to a third country for the first time in any commercial air agreement signed by the Russian Communists.

In bilateral pacts signed with other countries outside the Soviet bloc, the Russians have carefully skirted any mention of Fifth Freedom traffic—the right of a carrier of one country to transport passengers from a second country to a third (AW Sept. 15, p. 41).

Although the Soviet-India agreement specifically restricts scheduled service by Russia's Aeroflot and India's Air India International to the present operated Delhi-Amritsar-Tashkent-Moscow route, it does provide for a commercial agreement that could lead the way to an expansion of service by the two carriers beyond the present route.

It is now generally known that the Russians are eager to extend their routes to the Far East from Delhi via Rangoon. At the same time, India's successful program in developing a system of 24,893 unduplicated route miles for its Air India International is evidence enough that no concessions will be made to the Russians without the benefit of reciprocal rights.

The India-Soviet pact closely follows the pattern set in the agreement between Great Britain and Russia. However, the language of the former agreement has been strengthened and details of the operation have been enlarged upon, indicating that the Russians are becoming more sophisticated in working out bilateral terms.

The reference to Fifth Freedom rights in the India pact, for example, suggests that the Soviets have learned they may be denying themselves the right to carry through traffic on their own airline beyond the route limitations established by bilaterals made with other governments. It also suggests that Air India is not overlooking the potential traffic value to a Delhi-Moscow-London route.

Route Preferred

Air India would prefer a direct route from Delhi to London via Moscow—a route it may win if Russia continues to press hard for a route beyond Delhi. Until such a route materializes, however, the carrier will stress through-connecting service to London via Aeroflot from Moscow east. Air India's current advertising campaigns are emphasizing this service. The result has been a load factor on the Delhi-Moscow route since service began on Aug. 15 that is higher than the load factor on any other route segment operated by Air India.

Air India last year carried 88,312 passengers as compared with 79,800 in 1956 and 56,445 the previous year. Much of the credit for the traffic growth and the expansion of service into Russia must go to the airline's head, J. R. D. Tata, who founded Air India's predecessor company in 1932.

Tata has been chairman of Air India since 1948 when it was nationalized, together with its sister company, Indian Airlines Corp. Air India operates the nation's international routes; India Airlines handles all domestic service.

Gains made by Tata and his staff officers during the past few years have been accomplished in the face of stiff obstacles. As one of the most undeveloped countries in the world, India is not yet attuned to the technical requirements of modern air transportation.

Signs of industrial progress in certain areas of the country, such as the Bhakra Dam—highest in the world—and the steel industries or the Damodar Valley scheme, fail to hide the ignorance and hierarchy that now characterize the majority of India's some 400 million people. Tata has no middle class to draw from and, thus, no reservoir of skilled or trained labor with which to create a working core for his company.

Tata must struggle with a caste system, including the Brahman, Rajput, Vaisyas and Sudras, who still recognize the Untouchables as a polluting element despite the fact this classification has been banned by law. Tata would like to see the development of a new caste made up of airplane mechanics, engineers and technicians if the caste system is to remain a part of India's makeup.

India's first five year plan completed

Boeing Rolls Out First 707-320 Intercontinental

First Boeing 707-320 Intercontinental jet transport rolls out at Renton, Wash., facility of Boeing Airplane Co. Company said the first 707-320s will be delivered to Pan American World Airways next summer, following Boeing and Civil Aeronautics Administration flight and certification tests on first two airplanes. Intercontinental is powered by four Pratt & Whitney JT4A-3 turbojet engines; Wingspan is 142 ft. 5 in., compared with 130 ft. 10 in. on the 707-120. Aircraft can carry up to 160 passengers.

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*France is 4 hours and 37 minutes from New York at the speed of sound.

WORLD'S LARGEST AIRLINE/WORLD'S MOST PERSONAL SERVICE

in 1956 and the current second five year plan have made important contributions to the education and economy of the country. But Air India officials realize that the drive for mechanization and modernization will be a long, drawn-out process and will take a heavy toll in the operational costs of both airlines. For example, despite the relatively small volume of passengers it carries, Air India employs 4,500 people as compared with 6,000 persons employed by Delta Air Lines last year when it carried 2.7 million passengers.

Baggage is still handled without benefit of carts or belt conveyors, and the airline's ground crews carry baggage on their heads or shoulders, caravan style, one man for each bag at the majority of India's airports.

In the maintenance and overhaul shops, production lines are unknown. Spares, parts and tools are moved entirely by hand. Manual labor keynotes the company's planning programs in technical matters.

Despite such technical drawbacks, Air India and Indian Airlines have maintained a pace in their re-equipment programs that has kept them on par or, in most cases, ahead of their competition. At a time when TWA was operating DC-4s on routes served by Air India, when BOAC was using Argonauts and Pan American was flying the Lockheed 049, Air India introduced the Lockheed 749 Constellation.

The company was the first to put Lockheed 1049Gs on the European route to the Far East and, in all likelihood, it will be the first to fly the Boeing 707-420 series on its routes. Three of the Boeings, powered by Rolls-Royce Conway engines, have been ordered by Air India for delivery in 1960.

Tata is confident that the more modern equipment will create no greater problems operationally than he has faced in the past. Despite the shortage of skilled labor, for example, Indian Airlines completed its shakedown period with its fleet of Viscounts without encountering serious difficulties.

The carrier sent 46 ground crew members and 30 pilots to airlines operating the Viscount and to Vickers-Armstrongs in Great Britain for complete training on the airplane. The group returned to establish a training school here and construction on a Viscount maintenance dock was completed before the first Viscount was delivered in August, 1957.

Tata has similar plans for introducing the Boeing. A Boeing simulator and test cell will be installed at Bombay and an intensive training program is now in the making in preparation for the turbojets. Most Air India officials now feel that this accelerated training program will enable the company to expand without causing any great increase in the present personnel complement. All pilots used by both companies are now native Indians who have been trained by the airlines from primary flight to commercial status.

Air hostesses were originally trained by one TWA stewardess sent to Bombay to establish the airlines' hostess school. Since that time, all training of hostesses is done by the company.

Air India officials are generally satisfied with the operating arrangements with the Russians. The bilateral agreement calls for the frequency and scheduling of service on the "basis of complete equality and mutual benefits."

Navigational facilities required for the operation of the service are carefully set forth in the agreement. Arrangements for the charge of user fees are also included in the bilateral pact, a clause seldom found in other agreements signed by the Russians.

Provisions covering the handling of aircraft involved in accidents or forced landings are virtually the same as those agreed to in the British-Soviet pact. Unlike other bilateral agreements signed by the Russians, the India agreement contains no mention as to the language which will be spoken on the airways by crews of either airline. The agreement was completed in Hindu, Russian and English languages.

Air India has bilateral rights to serve the U. S. via both Atlantic and Pacific gateways but the company has no immediate plans for adding the additional mileage to its system despite the obvious advantages to this service. In addition to the Moscow route, Air India classifies the run between Bombay and London as a major route segment of its system. Alternate stops on the route, which is served by seven weekly flights, are made at Rome, Paris, Prague, Dusseldorf, Zurich, Geneva, Cairo, Beirut and Damascus.

The airline operates a fleet of 10 Lockheed 1049G Constellations, which offered a total of 50 million capacity ton miles during the year ending last March 31. In addition to its European service, Air India operates to East Africa via Karachi and Aden, to Hong Kong and Tokyo and, in 1956, the first service to Sydney was implemented.

By act of the Indian Parliament in 1953, all Indian airlines were nationalized. The decision to nationalize and subsidize the two carriers was based on an inability of either company to raise capital to finance future equipment.

Both carriers place emphasis upon passenger service as the competitive strategy most likely to win in the race for traffic once high-capacity jet transports are introduced on a large scale. Good passenger service is a focal point in the training of its personnel and is reflected in the widespread reputation Air India has earned among world travelers during the past few years.

B. R. Paten, Air India's vice chairman, told AVIATION WEEK that the development of a fine service program has not been difficult. He explained, "in India, the natural inclination to serve is a national characteristic." This stress on passenger service has been extended to the Moscow-Delhi route and is a selling point the company will use in developing the route.

11-18s for China

Moscow—Aeroflot, Soviet state-owned airline, reports that "the time is not far off" when the Soviet 11-18 Moskva turboprop transports will begin operations in Communist China. Aeroflot officials say a large group of Chinese pilots, engineers and mechanics are now in Moscow for 11-18 training. The airline added that instruction has been simplified since many of the Chinese understand Russian well enough to dispense with interpreters.

Minhanduy—Airline of People's Democratic China—now operates a fleet of 11-14s and Li-2s on domestic routes that serve Russia through the Alma Ata and Irkutsk gateways.

Northwest Nears End Of Finance Program

New York—Northwest Airlines financing for its 10 Lockheed Electras and five Douglas DC-8s will be substantially complete if a financing program including bank and institutional loans and sale of preferred stock can be realized.

Northwest is negotiating a 20-year $40 million loan with institutional investors—insurance companies, pension funds or trust funds—and a seven year bank loan of $32,500,000. The convertible preferred stock, which probably will be sold next week, is expected to bring in $11,000,000.

The $73,500,000 total anticipated would first be used to retire Northwest's current $34 million bank debt and the $39,500,000 balance applied toward equipment purchases. This totals $67.5 million, less $3.5 million allowed by Lockheed for trade-in of nine Boeing Stratocruisers at a unit price of about $390,000, and $6,731,000 trade-in allowed by Douglas Aircraft Co. for five DC-7s, at a unit price of about $1.3 million. This leaves a balance of $17,768,000 which Northwest would be required to raise from depreciation reserves and retained earnings.

Granting of the institutional and bank loans is dependent on Northwest raising a minimum of $10 million in the preferred stock sale. The institutional loan will carry a 6% interest rate; the bank loan 4-5%.

Airline Income & Expenses —Third Quarter, 1958

(IN DOLLARS)

	Passenger Revenue	Mail Revenue	Property Revenue	Charter Revenue	Federal Subsidy	Total Operating Revenue	Total Operating Expenses	Net Income Before Taxes
DOMESTIC TRUNK								
American	73,281,983	1,657,258	7,518,798	334,595	.....	83,121,389	72,917,506	11,691,520
Braniff	13,674,979	372,995	879,295	51,976	.....	15,058,490	13,670,773	1,308,813
Capital	24,782,430	569,500	934,877	16,372	.....	26,500,447	25,032,930	564,874
Continental	7,332,416	137,581	295,803	110,764	.....	8,003,574	7,888,419	—209,086
Delta	18,238,814	436,601	1,391,383	222,211	.....	20,452,114	19,600,679	724,996
Eastern	54,956,313	947,773	2,416,701	38,141	.....	58,809,483	56,785,514	1,692,136
National	10,063,721	228,392	645,304	230,407	.....	11,378,485	12,367,303	—1,150,008
Northeast	5,500,110	76,313	214,926	3,337	.....	5,831,664	7,350,891	—1,488,215
Northwest	1,759,633	480,424	1,254,531	77,533	.....	19,493,741	16,690,693	2,608,878
Trans World	55,302,055	1,144,089	2,921,025	111,003	.....	59,647,861	52,072,474	7,004,469
United	73,891,295	2,288,850	6,192,504	760,482	.....	83,653,579	71,037,523	12,038,284
Western	11,173,824	221,105	444,466	69,461	.....	11,964,292	10,346,245	2,150,307
INTERNATIONAL								
American	1,643,318	9,619	195,206	.....	.....	1,910,528	1,717,397	194,206
Braniff	1,721,154	23,261	218,378	.....	.....	1,992,763	2,010,168	—43,130
Caribbean-Atlantic	517,841	5,789	16,732	7,731	.....	567,951	500,785	66,617
Delta	1,340,754	14,672	88,318	2,568	.....	1,455,871	1,392,561	62,139
Eastern	6,410,277	100,640	219,001	143,868	.....	6,880,845	6,104,610	736,886
Mackey	334,911	.....	5,514	33,528	.....	375,477	398,157	—22,655
National	1,138,357	10,162	69,757	26,568	.....	1,246,848	972,651	266,983
Northwest	6,581,253	1,632,348	953,532	500,935	.....	9,931,204	7,067,549	2,743,118
Pan American								
Alaska	953,638	39,860	119,452	38,526	.....	1,167,405	1,277,347	—116,967
Atlantic	39,046,457	1,893,842	3,709,564	1,165,685	.....	46,564,701	39,002,867	7,302,582
Latin America	17,550,490	530,727	3,877,040	477,219	.....	22,910,582	23,742,373	185,730
Pacific	14,581,676	1,393,983	2,444,301	1,778,522	.....	21,037,445	17,330,763	3,746,937
Panagra	3,210,156	134,505	656,256	55,886	.....	4,309,477	4,692,446	—145,176
Resort	.....	.....	.....	1,627,460	.....	1,627,676	1,457,082	153,196
Trans-Caribbean*	.....	.....	.....	.....	.....	.....	.....	.....
Trans World	21,728,992	1,534,262	1,258,332	1,327,870	.....	26,705,457	23,397,299	3,113,754
UMCA	15,095	.....	3,094	.....	.....	18,215	40,437	—22,222
United	4,472,162	147,829	95,596	.....	.....	4,752,355	3,521,179	1,195,920
Western	354,848	1,444	5,001	9,270	.....	373,790	451,082	—88,569
LOCAL SERVICE								
Allegheny	1,678,796	32,738	86,265	3,300	1,271,604	3,079,230	2,423,282	639,022
Bonanza	647,003	9,288	32,037	5,191	408,662	1,107,519	1,166,973	—62,038
Central*	.....	.....	.....	.....	.....	.....	.....	.....
Frontier	947,576	24,488	100,665	11,790	713,553	1,812,927	1,885,647	—81,651
Lake Central	503,530	12,248	24,441	3,087	450,670	995,970	951,681	35,370
Mohawk	1,628,398	21,154	62,294	79,995	615,939	2,418,331	2,272,517	27,144
North Central	2,473,020	58,605	66,717	117,847	1,358,909	4,086,878	3,415,645	662,232
Ozark	1,312,451	25,129	74,655	13,741	668,396	2,104,951	2,029,620	62,491
Pacific*	.....	.....	.....	.....	.....	.....	.....	.....
Piedmont	1,614,460	29,078	56,940	12,018	621,859	2,399,139	2,245,144	143,477
Southern	671,137	21,918	35,710	1,940	817,470	1,554,459	1,236,430	323,375
Trans-Texas	922,238	29,893	58,306	16,062	743,887	1,782,055	1,697,854	80,707
West Coast	779,969	10,880	30,117	6,709	423,130	1,256,965	1,279,242	—30,610
HAWAIIAN								
Hawaiian Airlines	1,609,271	10,501	199,920	836,609	.....	2,686,289	2,182,334	447,468
Trans-Pacific	701,519	1,711	26,165	26,549	7,652	773,334	690,354	76,201
CARGO LINES								
AAXICO*	.....	.....	.....	.....	.....	.....	.....	.....
Aerovias Sud Americana	.....	.....	376,586	80,537	.....	464,146	463,650	20,647
Flying Tiger	.....	24,783	2,993,572	6,901,399	.....	9,910,790	8,315,556	1,692,150
Riddle	.....	16,947	1,164,664	964,457	.....	2,154,492	2,677,851	—662,051
Seaboard & Western*	.....	.....	.....	.....	.....	.....	.....	.....
Slick	.....	.....	.....	1,853,387	.....	1,940,801	1,529,899	—73,771
HELICOPTER LINES								
Chicago Helicopter	194,312	9,836	1,031	2,002	326,281	533,777	498,184	21,431
Los Angeles Airways	53,226	30,959	26,366	641	237,221	348,868	292,509	54,788
New York Airways	185,574	12,086	11,764	13,154	569,901	803,904	732,298	57,290
ALASKAN LINES								
Alaska Airlines	699,555	140,265	169,943	320,624	412,627	1,779,302	1,708,302	96,470
Alaska Coastal	286,654	27,220	32,866	35,036	94,550	492,283	403,981	63,302
Cordova	40,818	26,413	18,382	55,731	75,229	248,924	268,193	—26,426
Ellis	195,309	14,350	22,935	24,750	63,237	326,896	274,371	59,047
Northern Consolidated	285,332	88,072	152,148	60,199	171,429	790,762	646,209	140,895
Pacific Northern	2,396,163	191,461	317,608	17,416	383,466	3,332,064	2,688,371	604,440
Reeve Aleutian*	.....	.....	.....	.....	.....	.....	.....	.....
Wien Alaska	406,646	129,329	106,339	523,893	174,638	1,363,981	1,320,293	39,153

* Not available.

Compiled by AVIATION WEEK from airline reports to the Civil Aeronautics Board.

SHORTLINES

▶ **Allegheny Airlines** reports October air freight and air express boarding totaled 58,000 ton miles, a 12% increase over the previous record month of September. Thus far this year, Allegheny has carried 250,000 ton miles of air cargo for a 17% increase over the same period of 1957.

▶ **Air France,** under an agreement between the French and Canadian governments, has added tri-weekly passenger service between Chicago and Montreal and return. The agreement permits Air France to carry passengers between the two cities, whereas the carrier formerly could only carry passengers to the terminal cities of Chicago and Paris.

▶ **British Overseas Airways Corp.** advance reservations for its de Havilland Comet 4 jet transport service for December-January are 50% above advance bookings for similar piston engine service last year. The Comet 4 "Monarch" service, formerly operated by Boeing Stratocruisers, carries 52 passengers in mixed deluxe and first-class configuration. BOAC's winter schedules from Montreal and New York to Nassau call for a 20% increase in seats available, to 850 seats per week, using both Douglas DC-7C and Bristol Britannia aircraft.

▶ **Northwest Airlines** plans to begin service on its new Chicago-Florida route today on an initial schedule of eight daily flights between Chicago and Miami. Six will be nonstop and two will serve Tampa-St. Petersburg-Clearwater. On Dec. 15, Northwest plans to increase the service to 10 nonstop flights plus four via the Florida West Coast cities. The new flights will originate in Seattle-Tacoma, Minneapolis-St. Paul and Milwaukee and feature Douglas DC-7C first-class-coach service, Boeing Stratocruiser all-first-class service and Douglas DC-6B Stratocruisers all-coach service.

▶ **Pan American World Airways** plans to initiate daily Douglas DC-7C service today on its New York-Nassau route. Southbound flights will leave New York International Airport at 10:30 a.m., arriving Nassau at 2:30 p.m. Northbound flights will leave Nassau at 4:00 p.m., arriving New York at 7:50 p.m.

▶ **Riddle Airlines** has resumed scheduled cargo service to and from Philadelphia from its Florida points. The cargo carrier, which last March received CAB authorization to suspend Philadelphia operations for one year, says it is now feasible to resume twice weekly operations.

AIRLINE OBSERVER

▶ Watch for new action in the application by Aerolineas Peruanas S. A. for a foreign air carrier permit between Peru and Miami. Big objector is Pan American Grace Airways which has filed for subsidy as a result of heavy Latin American competition as typified by APSA fares (AW Oct. 13, p. 39). Panagra contends that APSA is not controlled by Peruvian interests as required by bilateral agreements but is dominated by its interchange partner, Transportes Aereos Nacionales of Honduras. Panagra charges that both Latin American carriers have refused to comply with a Civil Aeronautics Board subpoena directing them to submit more evidence on control of APSA and have also refused to offer any additional information requested by Panagra. Panagra has asked that the CAB reverse an examiner's ruling granting APSA one-year authority on the route and has also filed suit in a U.S. District Court in an effort to force compliance with the CAB subpoena order.

▶ **Military Air Transport Service will take over certain scheduled flights normally flown by Trans World Airlines. MATS says the flights, an interim measure during the strike of International Assn. of Machinists against the airline, are necessary to handle the flow of armed forces passengers and cargo traffic. The MATS flights, conducted to "meet the immediate requirements of the Department of Defense," will continue until the strike is settled or adequate substitute service is negotiated.**

▶ Denunciation of U.S. bilateral air agreement by France may result in withdrawals of certain operating rights if the agreement is allowed to expire (AW Nov. 17, p. 38). In such an event, both Air France and the U.S. carriers would stand to lose certain routes and revenue-producing privileges since the action on the part of one country would justify reciprocal action on the part of the other. For example, if France were to deny U.S. carriers the right to fly beyond Paris, the U.S. could amend Air France's permit to prevent the carrier from selling passage within the U.S. to any point beyond Paris. Because a large portion of Air France traffic to the east is generated in the U.S., losses to all carriers involved would be substantial.

▶ **Sud Aviation's triple-turbine transport helicopter development (AW Nov. 24, p. 35) is among the future equipment possibilities now under consideration by New York Airways. The French rotocraft is designated Project 3,200. Capacity will be between 20-25 passengers, cruising speed around 125 mph. Design is said to offer one-engine-out performance and all-weather capability.**

▶ Air route traffic control center to be constructed at Fremont, Calif., as a replacement for the present facility at Oakland Airport will be leased to the Civil Aeronautics Administration for 10 years by J. H. Pomeroy & Co. and McCloskey Co. Government holds an option to purchase the facility at the end of the initial rental period. Construction bids for seven other air route traffic control centers are under consideration by the Government Services Administration for the CAA.

▶ **Ozark Air Lines has retained Pilots Employment Associates to handle preliminary screening and selection of 50 new pilots the carrier needs to expand its present staff of 134 pilots to cover new routes tentatively awarded the carrier in the Seven States Area Case.**

▶ Reconfirmation will be continued by all but three scheduled airlines. At latest Air Traffic Conference meeting in Houston, American, Mohawk and Frontier decided to drop the reconfirmation plan as an ineffective means of curtailing noshows. Balance of the carriers voted to apply reconfirmation on all return or en route stopovers lasting overnight or longer. Minimum time limit on ticket pickups will be eliminated by all airlines after Dec. 1.

▶ **Sabena Belgian Airlines is shopping for new turbine helicopter equipment. Interest is being shown in the Sikorsky S-61 twin-turbine powered design being developed for Navy as the HS-2, but Vertol 107 also has been studied.**

▶ Northwest Airlines has received Civil Aeronautics Board approval to lease three DC-7C from Camaero Inc. at a rental rate of $38,000 per month per aircraft for use on the carrier's newly awarded route between Chicago and Florida.

Starts next month –the first jet service across the U.S.A.

A new and wonderful experience for travelers. In just a few weeks you'll be able to board an American Airlines Jet Flagship for the newest, most wonderful travel experience of your life. You'll fly Los Angeles to New York in only 4½ hours, New York to Los Angeles in 5½, more than three hours faster than present flying times. Soon American will extend jet service to Chicago, San Francisco, Dallas, Washington, Baltimore, Boston, Philadelphia and other major cities, creating more and more *useful* time for business and vacation.

Now, for the first time, getting there becomes a real pleasure. Your Jet Flagship will be a revelation in comfort beyond anything you have ever known. Your reclining

seats in the spacious cabin give you more privacy. You can see more because there is more window area. Ingenious innovations in lighting and air conditioning are yours to enjoy. Deluxe Mercury and economical Royal Coachman services will be offered in separate cabin sections on every flight.

A whole new world of flight. From a velvet smooth take-off, your 707 Jet Flagship will lift you promptly to radar-guided skyways, at tranquil cruising altitudes, far above or around the weather. Vibration is gone and engine noise incredibly reduced. At your destination, your baggage delivery will be speeded by another new convenience—American's luggage expediter system.

American Airlines invites you to be among the first to share the limitless opportunities of jet travel—the real pleasure of jet flight.

The Boeing 707 Jet Flagship is the most tested airplane ever to enter airline service

The prototype of the 707 made its initial flight in July, 1954. It has been flown continuously ever since, undergoing four years of the most thorough testing ever given any commercial airliner.

AMERICAN AIRLINES

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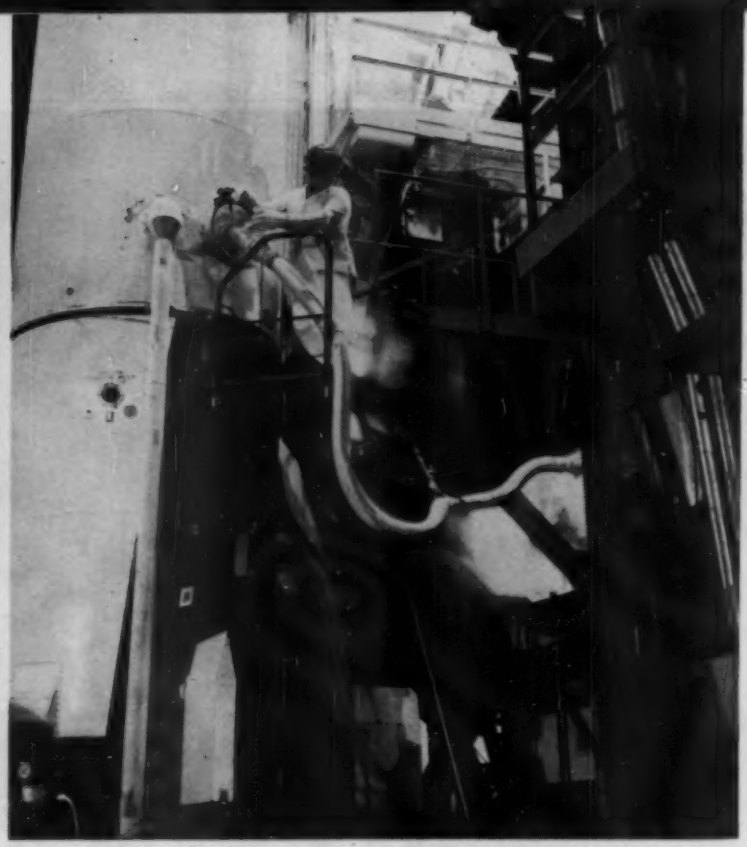
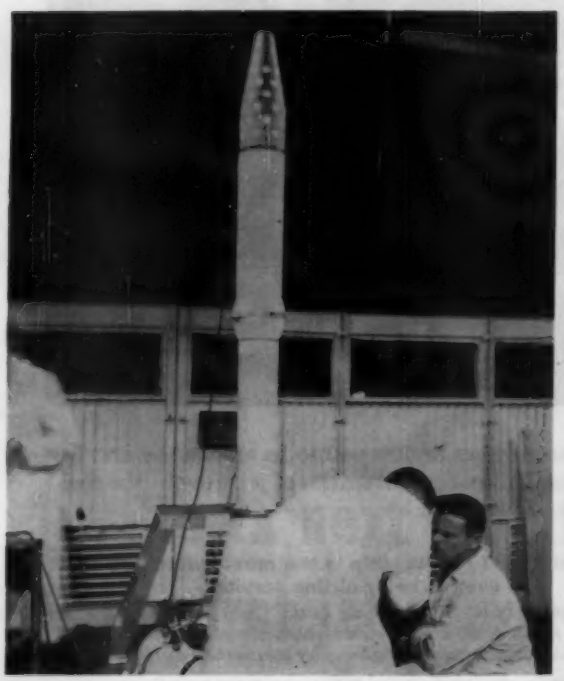


Army Ballistic Missile Agency prepares to fire Explorer VI in a Jupiter C satellite vehicle from Redstone pad at Air Force Missile Test Center, Cape Canaveral, Fla. Vehicle carried an International Geophysical Year satellite designed by National Aeronautics and Space Administration, but malfunction in upper stage rockets prevented successful orbiting of the 9.26 lb., 12-ft.-dia. inflatable sphere.

Army Prepares to Fire Explorer VI in Jupiter C



Final stage is checked (above) before launching (right). Aluminum foil and micro-thin plastic film satellite is given a "kick-in-the-apogee" by an extra rocket that points downward at launch but is oriented toward rear of satellite as it reaches position halfway around earth from launching site. Folded sphere is to be ejected and inflated by a cartridge. Atmospheric density and geodetic anomalies studies are objective.

Explorer Data Analysis May Take Years

By Evert Clark

New York—New details on the Army's Explorer satellite program—which probably will attempt to orbit a 100-ft. inflatable sphere as its next step—were revealed by G. Robillard of California Institute of Technology's Jet Propulsion Laboratory at the American Rocket Society's annual meeting here.

Explorer's Jupiter C vehicle has had nine missile and satellite firings so far, with six considered successful. It has put three satellites into orbit.

Robillard said the vehicle, "however unsophisticated it may seem as compared with Vanguard and however diminutive it may be as compared with Sputnik, has been to date exceedingly successful in accomplishing its objective: the exploration of space and the acquisition of fundamental knowledge of our planet's environment in the universe."

Army Ballistic Missile Agency handled development, construction and operation of the first-stage booster rocket and guidance system for the Jupiter C. JPL developed the three high-speed upper stages. Air Force Cambridge Research Center, the State University of Iowa and other groups contributed heavily to the Explorer program itself. First Jupiter C firing, in September of 1956 was a test of the vehicle itself. Second and third shots tested a model of the Jupiter nose cone under re-entry conditions.

Modifications to the Redstone first stage included enlarging of propellant tanks to increase burning time to 155 sec. and use of Hydyne fuel instead of alcohol to increase thrust from 75,000 lb. to 83,000 lb. No major modification to the engine was required.

Three upper stages, made up of 6-in. diameter scale models of an early version of the Sergeant missile engine, are contained in a "tub" which is spun by two battery-powered motors mounted in the instrument compartment. Also in this compartment, which is located between the first-stage tanks and the tub, are guidance and control equipment and spatial attitude control for aligning the upper stages horizontally before second stage is ignited.

Second stage is a ring of 11 scaled Sergeants, chosen because they had reasonably high performance and had undergone more than 300 static tests. Inside this ring is the third stage, consisting of three motors, topped by a conical structure that contains timer and batteries for firing the third and fourth stages. Structure also supports the fourth stage. Nozzle exit diameter on the fourth is somewhat smaller than on the other rockets, to allow launching clearance. This motor is attached directly to the instrument package and becomes a part of the satellite itself.

An improved propellant was ready for use in the fourth stage of Explorer I. By the time Explorers IV and V were scheduled to be fired, this improved propellant was qualified by extensive static spin-testing for use in the third stage, and a still better propellant was put into the fourth stages.

These propellant changes plus design refinements of fittings allowed for increases in payload of about 7 lb.

Firing sequence is as follows:

• **Tub is spun to 550 rpm.** prior to takeoff. At about takeoff plus 70 sec., a governor controlled by a programmer increases rotation gradually until it reaches 750 rpm. about 20 sec. before first-stage burnout. This eliminates resonance between spin frequency and bending frequencies of the missile.

• **Missile is tilted so that** trajectory is inclined approximately 40 deg. to the horizon at first-stage burnout by a depletion cutoff technique.

• **Five seconds after burnout** a timer activates six explosive bolts, separating the tank section and the first stage motor from the guidance compartment-plus-upper stage tub. Failure of Explorer V was attributed to poor separation that allowed the booster to overtake and ram the guidance tumbling the gyros.

• **Vehicle coasts to apex** about 404 sec. after takeoff. In this time, spatial attitude system aligns upper stages so they are exactly parallel to the local horizon. This uses guidance gyros for reference and small compressed-air nozzles placed at base of guidance for control.

• **Time of apex is determined** by a radar tracking plot which predicts apex time; an accelerometer in the missile which relays by telemetry the buildup of velocity in first stage, and Doppler tracking. All are fed into a small computer that averages the estimate, allowing for respective quality of the three types of data. Result is used to set a timing device which sends a radio command signal to the missile to fire second stage.

• **High speed stages burn for** about six sec. Two seconds coasting time is allowed between stages to ensure thrust decay. Pressure rise in the second-stage motors starts a timer housed in the conical support for the fourth stage. Eight seconds later it fires the third stage, and eight seconds after that, the fourth stage. Stages leave burned out earlier stages behind by breaking shear pins.

Failure of Explorer II was traced to a structural failure in the igniter support for the fourth stage. This light plastic cone apparently failed under spin, inertial and vibration loads but it was strengthened in subsequent vehicles.

Data collected thus far by Explorers is so extensive that it may be several years before it is completely analyzed, Robillard said. The information they have returned includes:

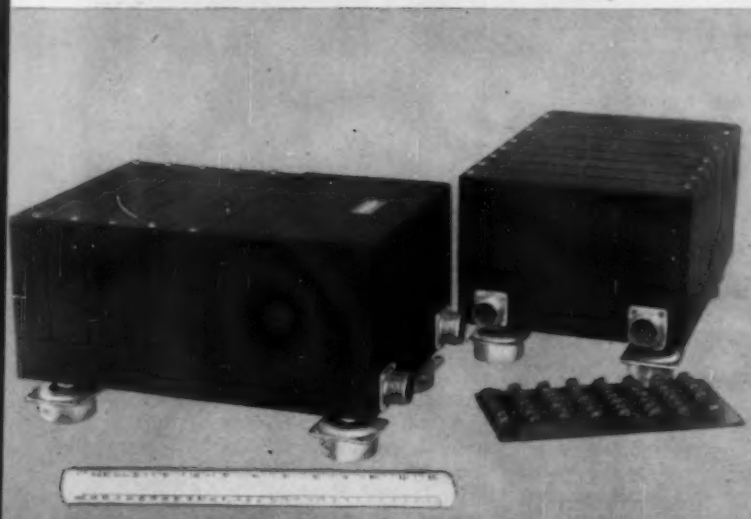
• **Explorer I.** Micrometeorite densities were 30 particles/sq. yd./hr. in the four-micron range and three particles/sq. yd./hr. for particles about 10 microns in diameter, confirming previous estimates and showing this offers no problem to space-ship designers. Internal temperature ranged only from 43 to 104F. Cosmic radiation, however, was estimated to be at least 1,000 times greater than expected.

• **Explorer III.** Orbit decayed to a 107.2 mi. perigee and 650.2 mi. apogee by two weeks before satellite died on June 29, and decay provided useful data on atmospheric density. Decay rate was 11.36 mi./day between launch and April 11. It was 11.95 mi. between April 11 and 25, and 14.99 mi./day from April 25 to May 31, and 14.16 mi./day from then until June 10, and 16.9 mi./day thereafter.

• **Explorer IV.** Preliminary analysis shows that the number of cosmic ray particles passing through the unshielded Geiger tube from all directions was on the order of 36,000/sq. cm./sec. At least 60% of them have enough energy to penetrate the lead shield around the other Geiger tube, Robillard said. There is an even greater density of low energy particles. Flux at about 1,400 mi. is about one million/sq. cm./sec. from all directions. Since density measurements change as the satellite rotates around its axis, it appears that more than 80% of the particles come from "one favored direction," he said. First two weeks' data indicated an increasing intensity with altitude, at all latitudes. Radiation varied both in quantity and quality with both latitude and altitude. Intensities in excess of 100 roentgens/hr. have been observed.

Explorer VI, carrying a 12-ft. diameter plastic sphere designed by National Aeronautics and Space Administration, was launched in October but upper stages apparently did not fire.

GEVIC a new concept in military airborne computers



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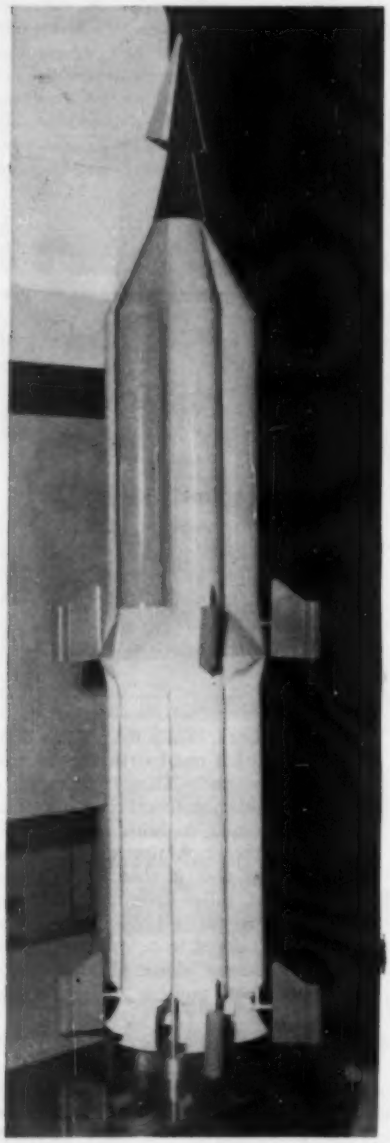
Boeing Proposes Solid-Propellant Space and Re-Entry Test Vehicle

New York—Space and re-entry test vehicle that would use proven solid rockets and cost only one-fourth as much as the liquid-fueled missile boosters now being used for such work has been proposed to the military services and the civilian space agency by Boeing Airplane Co.'s Systems Management Office.



BOEING Airplane Co. proposal for Project Start vehicle would cluster off-the-shelf solid rockets for low-cost space research tool which will be useful for Dyna-Soar testing and other programs. Verniers around bottom of each stage pivot along with vanes for attitude control. Test shape is mounted on nose of vehicle.

Called Project Start for Space Transport and Re-Entry Testing, the vehicle would employ both clustering and staging, giving it a wide variety of ranges, velocities, and payload-carrying capabilities.

Although studies on Start predate Boeing's entry into the Dyna-Soar orbital bomber competition and its assignment as assembly and test contractor for the solid-fuel Minuteman intercontinental missile, Start obviously would have application to both of these programs.

Model of Start displayed at the American Rocket Society's annual meeting and astronautical exposition here indicates that the basic rocket would be the Thiokol Sergeant engine.

This engine, used full size in the USAF-Lockheed X-17 re-entry vehicle and in a scaled down version in the Army's Jupiter-Explorer satellite launching vehicle, is the largest solid proven in a number of flights, and is in production for the Army's Sergeant surface-to-surface missile.

In the model, there are two clusters of seven rockets each, with one cluster atop the other. With a ring of six rockets surrounding a seventh in each of these clusters, the rockets could be fired in a number of combinations—giving the effect of a vehicle with as many as four stages.

For instance, if four were fired in the first cluster for lift-off, the remaining three could be fired later as a second stage; then the same pattern could be repeated in the upper cluster after first cluster had separated.

Length would be approximately 50 ft., based on 20-ft. length of the Sergeant engine. The over-all diameter of the Sergeant is about 31 in.

Test shape is mounted on the nose of the vehicle, above a fairing that completely covers the upper ends of the top cluster.

Vernier engines attached to four vanes on each cluster would provide stability and attitude control, being pivoted by a simple autopilot and serve system contained within the Start vehicle.

Verniers also would be proven, off-the-shelf items—JATO bottles with thousands of firings behind them. Control on either cluster could be maintained with as few as two of the vanes, which means that the vehicle would have "multiple-engine reliability." Vanes are similar to the wingtip con-

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Space Probe Recorder

Miniature magnetic recorder, developed by Lockheed Aircraft Corp. Missile Systems Division, can store three million bits of information yet it weighs only 8 lb., measures only 9 x 5 x 4½ in. Device, which uses 600 ft. endless loop of tape and records two channels of information simultaneously, can provide 96 min. of uninterrupted recording. Data can be read out at six times recording speed. Recorder is fully transistorized, consumes only 10 watts power. Lockheed has built four prototypes.

trol surfaces used on Boeing's Bomarc interceptor missile.

Addition of an upper stage such as Allegany Ballistic Laboratory's Meteor engine, developed for the Navy's Vanguard satellite vehicle and used in USAF's Thor-Able re-entry and lunar probe vehicles, would create a vehicle capable of putting 500-600 lb. in orbit, project engineers said.

Propellant Reliability

Boeing's investigation of solid and liquid propellant reliability, based on firings actually made and their failure and success, indicated a reliability ratio for solid propellants of almost 100 to one.

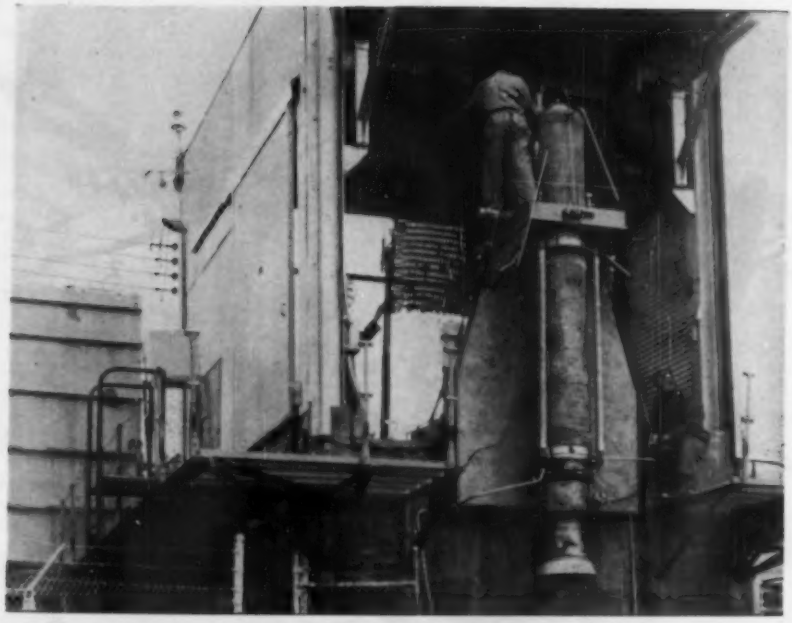
These figures took into account all sizes and types of both kinds of rockets, made by a variety of manufacturers.

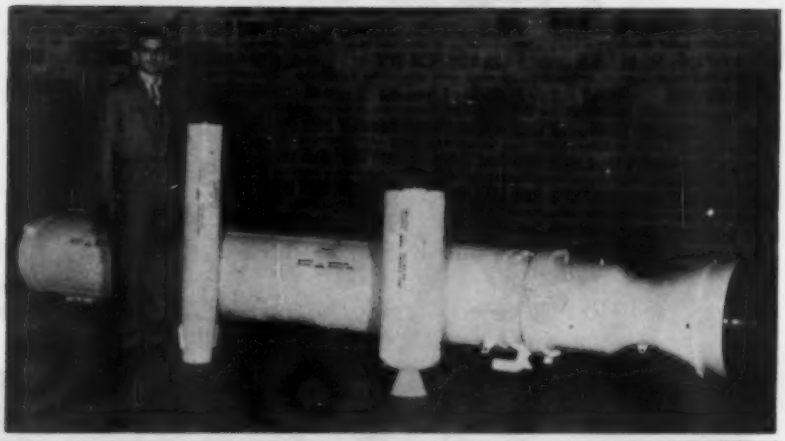
Cost studies indicate that Start could be produced for one-fourth the cost of the Jupiter and Thor intermediate range missile boosters being used or soon to be used in both satellite and space probe work. Major reason for the difference in cost is that Start's components are fully developed and are catalog items. Both Jupiter and Thor still are considered to be in the research and development phase, although both have made a number of successful flights.

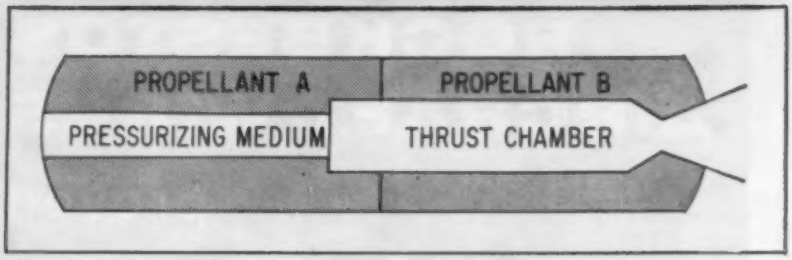
Preliminary Discussions

Preliminary discussions have been held with National Aeronautics and Space Administration, several Air Force offices and the Advanced Research Projects Agency.

Boeing is stressing low cost, high reliability, quick availability and versatility in its discussions of the proposed vehicle—important factors in view of increasing competition for space funds as more projects are approved.







New Rocket Family to 50,000 Lb. Thrust

First photo shows Reaction Motors Inc.'s new family of liquid propellant engines embodying basic flexible design that can be varied to meet virtually any requirements, the company reports. Large unit, resting horizontally on ground in bottom photo and on test stand in top photo, is 19-ft.-long 50,000-lb. thrust motor, first fired several weeks ago; on left is Guardian I currently in production and expected to start flight tests in a Navy missile before the end of this year; on right is Guardian II, under development for Navy, which has ordered a limited number. Guardian I and II are both slated for tactical missile use. Each of new family is designed to concept of providing complete powerplant system, from propellants to thrust chamber, can be factory loaded and stored for several years. Units can also be used as the actual missile body, adding warhead and fins to complete the weapon. Large motor has completely external thrust chamber, Guardian I has completely enclosed chamber and Guardian II has partially enclosed unit. Placement of chamber depends upon dimensional and center-of-gravity requirements.

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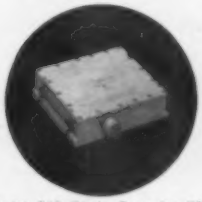
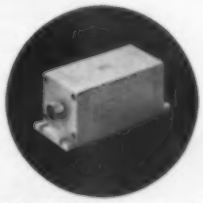


Model CA3 Strain Gage Amplifier



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4. 1944 — 162 Consolidated-Vultee B-24 Liberators fly 1,000 miles from African bases to bomb Axis Oil Refinery at Ploesti, Rumania.

5. 1923 — Two DeHavilland DH-4BM's achieve first mid-air refueling. With the aid of the mid-air refueling, two Army pilots stayed aloft four days over San Diego, California.

6. 1951 — North American F86E "Sabre" Jets help U. N. forces in Korea ring up 14-1 kill ratio over Russian-built MIG's.

7. 1940 — Curtiss P-40 Warhawks, flown by the famed "Flying Tigers," harass the Japanese Air Force throughout China and Burma, help stem the Japanese advance.

8. 1944 — Boeing B-29's Superforts begin strategic bombing of Japanese home islands, bombing 66 major cities, nine major seaport harbors.

9. 1944 — Lockheed's P-38 Lightning plays major role in continuing Allied air victories in both Europe and Asia.

10. 1942 — Sixteen North American B-25 "Mitchells" bring the war to the Japanese homeland — blast five major cities including Tokyo.

11. 1932 — The Gee Bee "Supersportster" wins the famous Thompson Trophy for the second year in a row. The 1932 speed — 253 m.p.h. — a new record that lasted until 1936.

12. 1926 — At 9:02 a.m. on May 9, a trimotor Fokker is the first aircraft ever to fly over the North Pole. Only two days later the dirigible Norge spent two hours flying about the Pole.

13. 1931 — DO-X, world's largest flying boat with wing span of 157 feet, features 12 engines which gave it cruising speed of 130 m.p.h.

14. 1931 — The "Winnie Mae" flies round the world in 8 days, 15 hours, 51 minutes. Two years later, the Lockheed monoplane cut the time to 7 days, 8 hours, 49½ minutes.

15. 1919 — U. S. Navy's NC-4 successfully completes first Atlantic crossing. Plane completed flight of 3,936 nautical miles in flying time of 52 hrs., 31 minutes with several stops en route from Far Rockaway, N. Y., to Plymouth, England.

16. 1929 — For the first time a complete "blind" flight is successful. A Sperry Gyro Horizon and Directional Gyro is used in a Consolidated NY-2 over a 15-mile course.

17. 1942 — Grumman Torpedo Bombers help sink four Japanese aircraft carriers in Battle of Midway Island — Japanese task forces turned back.

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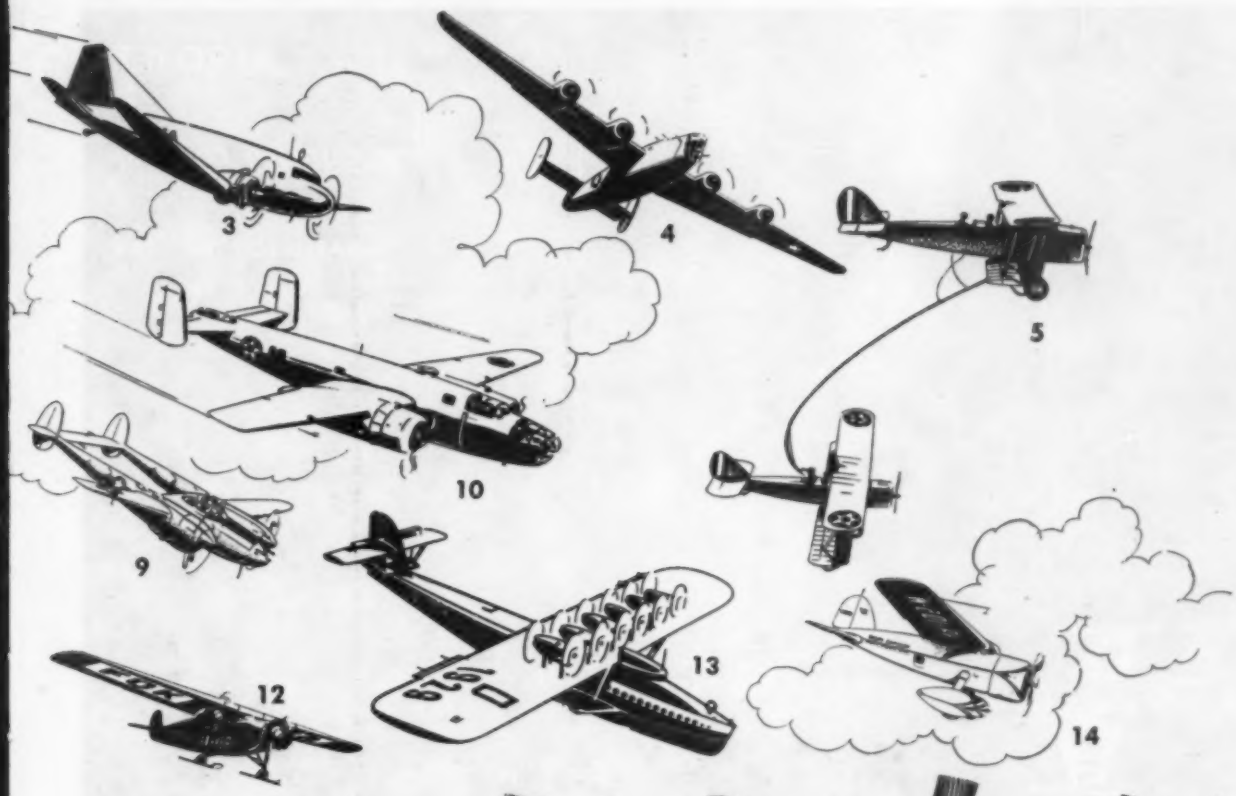

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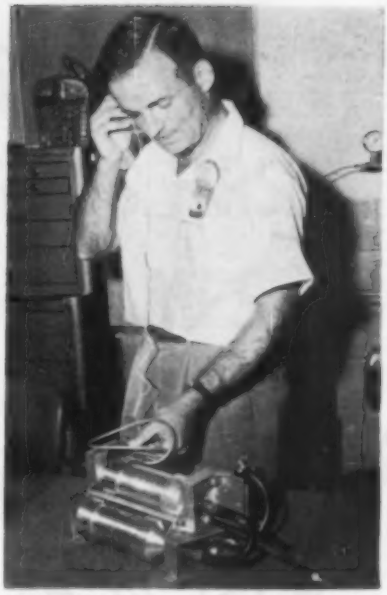
MOUSE compartment to be placed in Thor-Able nose cone is at left; mouse is investigating capsule and seal. Mouse cradle and cage are behind mouse; carbon dioxide absorber is attached to cradle. Space Technology Laboratories' Astrovehicles Laboratory directed mouse encapsulation. Flight (third mouse) covered 6,000 mi. at speeds reaching 15,000 mph.



MOUSE'S telemetry equipment is checked at Space Technology Laboratories. Lower cylinder houses mouse; upper cylinder contains air-purifying chemicals, water and a blower system. Cables projecting from cylinders contain telemetry connections. Unit will be placed in Thor-Able nose cone for attempted recovery after re-entry.

Mice Survive Thor-Able Re-Entry

New York—A small white mouse named Laska was fired some 2,600 mi. in a re-entry test nose cone and apparently survived 45 min. of weightlessness and all other stresses involved in re-entry from some 1,400 mi. altitude—including more than 60G deceleration.

Mouse was one of three fired in General Electric Co. ablation type nose cones on Thor-Able launching vehicles last April and July. Inclusion of the mice was done on a non-interference basis as a minimum biological experiment. First mouse was not instrumented, and none was recovered, but telemetry indicated the second and third mice lived throughout the flights.

Known as Project MIA (Mouse-in-Able), and conducted by Miss Franki L. van der Wal and W. D. Young of Space Technology Laboratories, the experiments were described in detail at the National American Rocket Society meeting here.

Although no generalized conclusions

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HARNESS (above) was designed by Space Technology Laboratories to prevent mouse from interfering with telemetry equipment during flight. Swivel knob on back snaps into socket in mouse container. Below, telemetry wires are attached surgically to mouse. Mouse's reactions to space flight, including weightlessness, were monitored during flight in Thor-Able nose cone.

can be drawn from the three flights, van der Wal and Young made these observations:

- **Acceleration loads** were paralleled by Laska's heart rate, but not by the heart rate of the third mouse, named Benji.
- **Since both Laska** and Benji flew to 1,400 mi. altitude and the Russian dog, Laika, reached only 1,050 mi. altitude in its satellite, the mice returned to earth from a greater altitude than that reached by any other living organism.
- **Decrease in Laska's** heart rate at first stage burnout was gradual, but at second stage burnout it was sharp. This was in opposition to the heart rate behavior of Laika. No trend was detectable in Benji's heart rate of first-stage burnout, but a distinct increase was apparent at the beginning of weightlessness.
- **Neither instrumented mouse** gave evidence of distress due to weightlessness.

GENERAL ELECTRIC DESIGNS WORLD'S FIRST FLUORESCENT LAMPS

especially for civilian aircraft lighting

Actual Size

Freedom in lighting design is now possible with General Electric's dramatic new aircraft fluorescents. Only ⅝" in diameter, they hug ceilings and bulkheads, allow interior fixtures to reflect the sleek exterior lines of modern aircraft.

G-E aircraft fluorescents have *rugged*ized cathodes built to log trouble-free operation under all conditions of vibration and impact. And the new miniature pinless base allows quick, positive locking.

They are rapid start lamps—usable on a dimmer circuit if desired. Three lengths are now available: 5 1/16" (*4 watts*), 11 1/16" (*8 watts*), 20 1/16" (*13 watts, also in red for pilots' compartments*).

Ballast specs will be available soon. Write today for the whole story on the new G-E aircraft fluorescents. General Electric Company, Miniature Lamp Dept. AW-128, Nela Park, Cleveland 12, Ohio.

Progress Is Our Most Important Product

GENERAL ELECTRIC

ROUGH aluminum and magnesium castings (left), trucked to Douglas from subcontractors in New York, New Jersey and Pennsylvania, are checked for flaws with X-ray unit. After large diameters are machined on vertical turret lathe, castings are drilled and tapped (right).

Douglas Tailors Plant for Nike Hercules

By Michael Yaffee

Charlotte, N. C.—Producibility factor of the Army's Nike Hercules surface-to-air missile has resulted in a Douglas Aircraft Co. plant designed exclusively for missile production and believed to be the largest effort of its kind in the United States.

Douglas engineers claim that because of plant design and the missile's producibility, the Charlotte Division produces the missile at less cost than anticipated by Douglas. The reasons:

- **Exclusive design** has no commitments to existing equipment, set floor plans or established procedures.
- **High rate** of production.
- **Tooling** made especially for missile production.
- **Lessons learned** in the manufacture of similar vehicles.

Before Douglas moved into the Army's Charlotte Ordnance Missile Plant, the company held a number of conferences with the Army and with representatives of Western Electric Co., the prime contractor for the Nike family of missiles. It was then decided how the plant was to be rehabilitated and what new construction was needed. On Dec. 20, 1954, Douglas signed a facilities contact with the Philadelphia Ordnance District for design and operation of the Charlotte plant.

Thus, where many plants simply fit missile production into existing facilities and often spread it widely around existing production lines, the Charlotte plant was designed solely for integrated missile production.

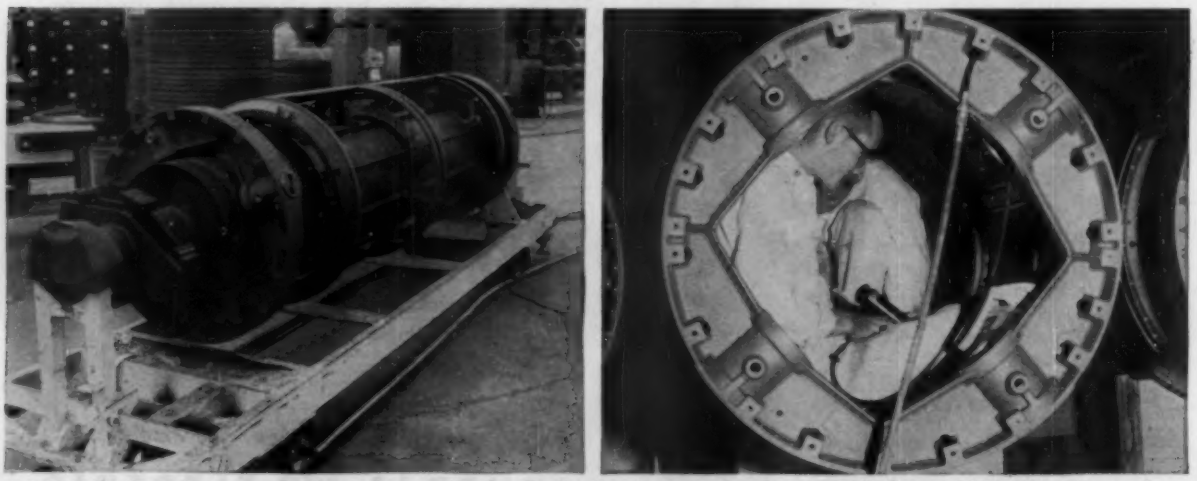
Douglas, uncommitted to existing floor plans or equipment, was able to carry out extensive cost studies to find the most efficient way of producing missiles.

At the same time the 35 Douglas employes who were transferred from Santa Monica, Calif., to form the nucleus of the new operation brought with them missile production experience gained from work on Sparrow I, Honest John and Nike Ajax.

The design of the Ajax, of course, had been set and there was little that could be done to alter its production. It wasn't until the Hercules went into production that the Charlotte plant was really to come into its own.

Minus booster, the Nike Hercules is 27 ft. long. Body diameter is 32 in. Missile skin is aluminum throughout; main and center fins also are aluminum, while elevons and forward fins are magnesium.

The skeleton of the airframe con-



HERCULES airframe begins to take shape when machined and painted castings are placed on assembly fixture (left). After skin panels are riveted on, workers enter main engine section to shoot silastic sealant into seams (right).

BORE-MATIC unit (left) machines casting bores to size. After inspector checks castings with production inspection gage (right), they get alodine treatment and then are covered with zinc chromate primer.

sists of a series of narrow cylinders and a small number of longitudinal stiffeners which serve as the load-carrying members of the vehicle. The cylinders are cast from either aluminum or magnesium to save weight and the time and cost of extensive machining. Stiffeners are extruded from the same materials for the same reasons.

Aerodynamic heating and stress determine the choice of casting material at some specific joints in the airframe. But generally, selection of cylinders is decided on a cost-weight basis. As a result, most of the castings in the Nike Hercules airframe are aluminum.

Airframe sections begin to take shape when the longitudinal stiffeners are joined to a series of spaced cylinders ringing a horizontal assembly fixture. Skin panels are riveted to the cylinders and stiffeners. External protrusions are later shaved flush to give an aerodynamically smooth skin. Joints and seams are sealed with silastic material to keep rain and dirt out.

Two of the three main body sections are bolted together at the plant. The third, which contains the warhead, is added at the missile launching site for purposes of safety. For the same reason, the solid propellant sustainer, which is fastened to the castings in the first two body sections, is not inserted until the Hercules is in the field.

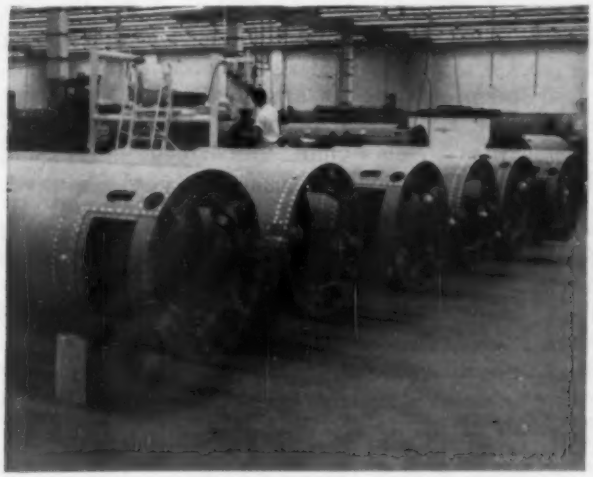
Trapezoidal Sheet

The trapezoidal aluminum sheet, which is used for the nose cone, is first roughly shaped on a long, small diameter roll which drops into a rectangular trough. Three men slide the sheet slowly across the trough as the roll keeps dropping, forcing the sheet to curve upward. When half the sheet is curved, it is removed and turned around. The half that is still flat is then fed across the trough and curved to meet its opposite edge.

The fully curved sheet is seam welded into a rough nose cone. This is dropped into female half of a large bulge die which is sunk to floor level. The male half of the die is inserted; the cover secured and the cone is blown out to the required dimensions at 600 psi.

Welding is kept to a minimum in the construction of the Nike Hercules. Initial cost studies indicated that riveting was preferable in terms of man hours and facilities, particularly at Charlotte where Douglas was starting from scratch. Welding affects the straightness of a part, for example, and valuable man hours were sure to be lost just straightening welded items out.

The choice of cylinders as the main internal, load-carrying elements was another matter. The alternative was to start with aluminum or steel bar stock. While the bar stock would provide the strength needed for internal load carrying members, it would also have to undergo extensive machining to pare away the excess weight. Use of bar stock, it was decided, might be practical in missiles that were to be



FINISHED airframe sections (left) are hoisted onto overhead monorail for final assembly. As sections move along hairpin-shaped course, workers install internal mechanisms and insert cable harness for the guidance and control package (right).

FITTING THE MACHINE TO THE MAN

A New Idea in Helicopter Piloting

This steel giant, world's most advanced dynamic flight simulator, is nearing completion at Bell Helicopter Corporation. It is one of the most important tools in the Army-Navy Instrument Program, of which Bell is the rotary-wing industry coordinator. Goal of this long-range program is to provide ideal all-weather cockpit instrumentation, created for the helicopter's own special needs. In short, to put an actual picture of the outside world right in the cabin . . . making helicopter piloting almost as simple as turning on the family television set!

Philosophy behind Bell's extensive research and development embraces an entirely new concept. Historically, both fixed wing and helicopter cockpits have been designed around the instruments. Now Bell seeks to fit the *machine* to the *man*. Improved displays and controls will relieve the pilot of today's instrumentation complexities . . . allow him to perform only those functions which he does best.

Successful completion of ANIP program will have far-reaching benefits . . . for the helicopter, the aircraft and for every branch of military service. Its principle can be adapted to every man-made machine . . . missiles, ships, submarines, tanks . . . perhaps even tomorrow's automobile. Selection of Bell as industry coordinator for this all important program is indicative of Bell's stature and reflects the pioneering spirit that has made Bell the greatest name in helicopters.

BELL Helicopter CORPORATION

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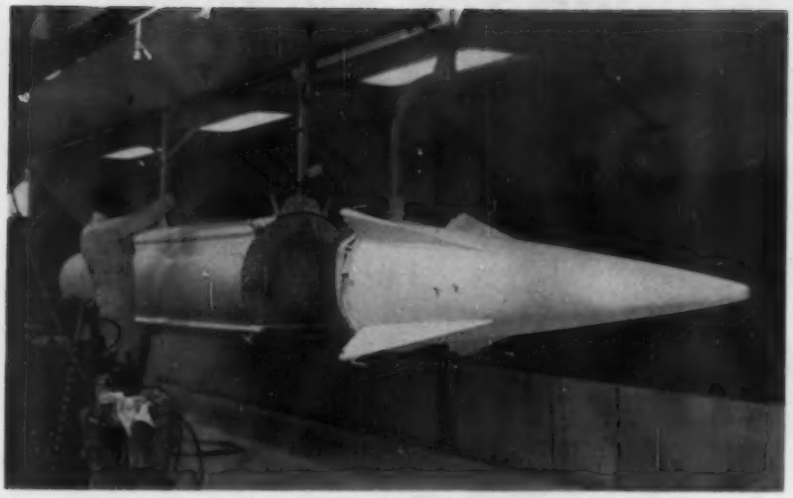
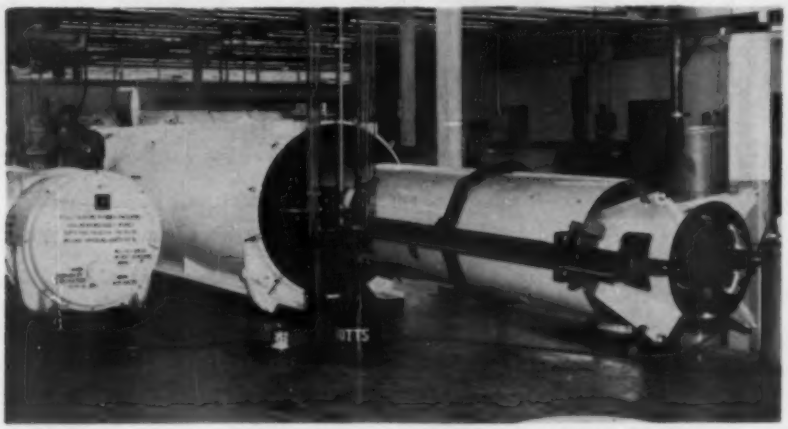


MAIN engine section and nose cone of Nike Hercules get finish coat of white as they move through continuous paint and drier set-up in final assembly building.



READIED for trip to missile site, nose cone is reversed and inserted into main body section which then goes into special shipping container.

produced in very small quantities.

But for a large scale operation such as the Hercules, studies definitely indicated the use of castings, Douglas states. They are comparatively inexpensive to produce, in large quantities, light in weight, and require a minimum of machining. And with the development of special tooling, much of which Douglas makes itself in a well-equipped machine shop at the Charlotte plant, castings permit rapid missile production. In one operation, for example, the cast cylinder is placed flat-side down; a multiple spindle is lowered and simultaneously drills many holes through the cylinder wall in a 360-deg. pattern.

The use of special tooling, in turn, is made economically feasible by the high rate of production in the Hercules operation. Design and manufacture of the Hercules, for example, is similar in many ways to that of conventional manned aircraft; but the comparatively low production rate of the latter makes hand operations more attractive. In a case where an aircraft part required a number of similar holes, for instance, they would likely be drilled in sequence by hand rather than by a machine with a coordinated hole pattern.

Missile Experience

Veteran in the airframe business and with missile experience dating from 1941, Douglas was able to bring much valuable knowledge to bear on the Nike Hercules operation. But the experience most directly applicable to the production of the Nike Hercules derived chiefly from Douglas' work on the Honest John and on the Nike Hercules, according to Donald Jamtaas, chief engineer at Charlotte Division. Honest John approaches Hercules most closely in size; Ajax, in internal structure.

An important carryover from the Ajax program cited by Jamtaas, for example, is the overhead conveyor line used in the final assembly of the Hercules. In its early work, Douglas used dollies extensively to move missile sections. The switch to an overhead conveyor enabled the company to get rid of most of the dollies and unclutter the floor. Even more beneficial, it raised the airframe sections to eye-level, permitting workers to install equipment and run the required tests faster, more easily and with less physical strain.

At the same time, the differences between the Hercules and other missiles are as significant as the similarities. The construction of the Ajax airframe, for example, differs noticeably from that of the Hercules. The smaller Ajax body is made up to a large degree of long tubular castings bolted together. These castings, which are almost fully machined, form both the load carrying structure and the external surface. Cost and weight of such a structure, Jamtaas declares, would be prohibitive for the larger Hercules airframe.

Soviet Union Reports ICBMs in Production

Moscow—The Soviet Union's intercontinental ballistic missile has reached production status, it is claimed here. A report that the USSR is now producing ICBMs was buried in a single sentence of an 88-page outline of Russia's new seven-year plan. "Production of intercontinental ballistic rockets has been successfully set afoot," it said.

The plan carried no further refcrence to missiles of any type although it did state in the same paragraph that "preparations are being made for travel to celestial bodies."

Since the Soviet announcement last August of an ICBM launching, Premier Khrushchev has several times indicated it is in production but this is the first definite claim to such status.

Also included in the seven-vear plan is a forecast that air travel will increase approximately sixfold in the Soviet Union during the coming seven years. It asserts the introduction of large turbojet and turboprop airliners will be responsible for making air transport one of main categories of passenger transport in the USSR. To handle these modern aircraft, more than 90 airports are being built or modernized, the report said.

The network of feeder lines will receive particular attention during the seven-year period between 1959 and 1965, the outline of the plan indicated.

In fields allied to aviation, the plan called for sharp boosts in the output of the plastic and aluminum industries as well as substantial increases in electronic and machine tool output.

Output of metal-cutting machine tools is to reach between 190,000 and 200,000 in 1956—an increase of 1.4 to 1.5 times over 1958. This will include

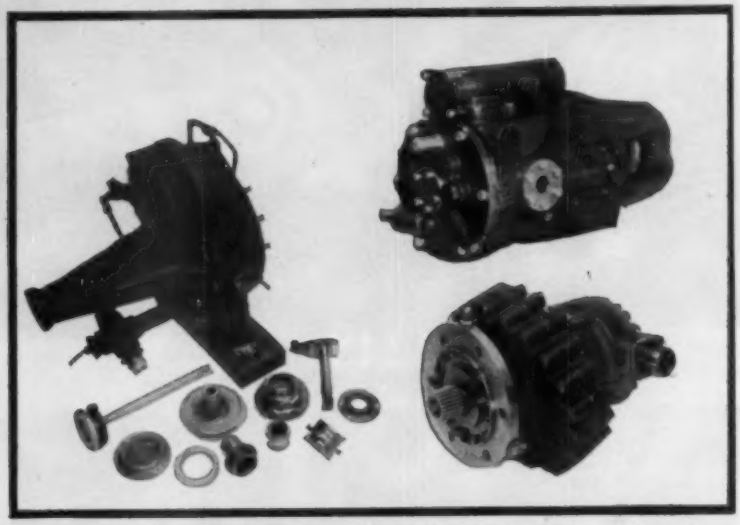
Proving Ground for System Components in All Environments

High-temperature fluid evaluation conducted in an environmental lab oven with operation at 600° F oil in, 800° F ambient.

Control console for one of the ovens and dynamometer test stands at Sundstrand's environmental lab.

800-hp diesel quad-units provide power for testing aircraft electrical systems upto 250 kva.

Any desired electrical system can be established quickly with this patchboard panel at Sundstrand's environmental lab.



Unretouched views of Sundstrand constant speed drive, gearbox, and hydraulic pump after operation at 600° F oil in, 800° F ambient.

Sundstrand Aviation's new and fully equipped environmental test facility employs specially designed equipment for simulating an unusually wide range of environmental conditions.

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These complete environmental test facilities provide a unique proving ground for Sundstrand Aviation's advanced research work in the development of secondary power systems and components to meet the demands of tomorrow's ultrasonic aircraft and missiles.

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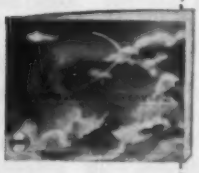

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38,000 specialized and aggregate machine tools. Production of some 36,000 forging and pressing machines in 1965 is called for by the plan.

Complete sets of automatic and semi-automatic machine lines will total between 250 and 271 in 1965 if the targets are met. Approximately $10 billion is earmarked for precision instruments in that year.

Aside from a brief statement on the ICBM, the seven-year plan contained no direct reference to the Soviet armament program. But Premier Khrushchev touched on it in a speech made the following day at a reception for graduates of military academies of the USSR armed forces. In this he mentioned not only intercontinental missiles but also referred to "submarines equipped with ballistic rockets and flying bombs."

"It is now enough to press one button and not only airfields and means of communications of various staffs and headquarters but also whole cities may go up in smoke, whole countries may be destroyed," the Soviet premier said.

This came only a few days after an article in Sovietskaya Aviatsia reported the West was hastily seeking new means of defense to protect itself against "inevitable retaliatory blows" which it would face in event of war. Col. S. Reidel described material recently published in the Western press on improved fighter aircraft and guided missiles.

"The arguments, calculations and conclusions published in foreign aircraft periodicals suffer from a certain onesidedness and bluntness, inasmuch as the aerial targets of the enemy are regarded as relatively passive objectives having no radar nor similar or better guided missiles for repulsing the attacks of fighter interceptors," he said. "But this is understandable. Foreign aircraft publications are vitally interested in advertising the products of the biggest companies which make planes and aviation armaments."

Transporter-Erector Designed for Rockets

Transporter-erector for large rocket engines now under development will be built by the Hufford Corp., El Segundo, Calif., under $225,000 contract from Thiokol Chemical Corp.

Vehicle, a tractor with a special trailer, will be used to transport rocket engines to test sites and to erect rockets in either horizontal or vertical position for static firing. Control during erection of the engine will be accomplished with a combination of hydraulically-actuated and electric hoists. Called the "transrector," the unit will be capable of handling engines up to 35 ft. long and 85 in. in diameter and weighing 80,000 lb.

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Progress Report No.

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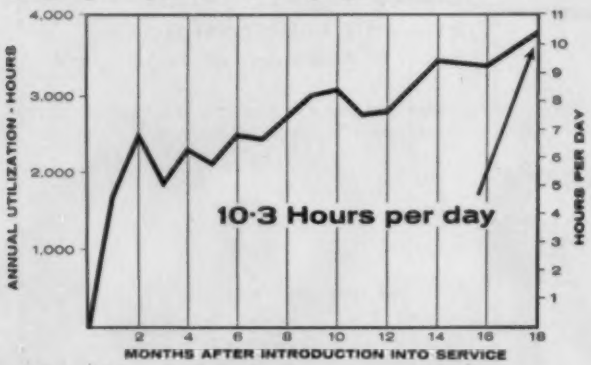
How have they rewarded

Facts and figures of the operators themselves—these provide the conclusive evidence. They bear witness to the soundness of the basic Britannia concept. They prove the Britannia in airline service to be exceptionally reliable, capable of attracting new traffic, and immensely flexible. In a word—profitable.

1 Reliable. Britannia's jet-prop engines have established an all-time record, since life between overhauls on the Proteus 705 has been raised by the Air Registration Board to 1,600 hours after only 18 months' service—a rate never before achieved by any engine, piston or turbine. "Engines virtually trouble-free"—*El Al.* "New standard of mechanical reliability . . . nearest approach to ideal propulsion unit for transport aircraft"—*Aeronaves.*

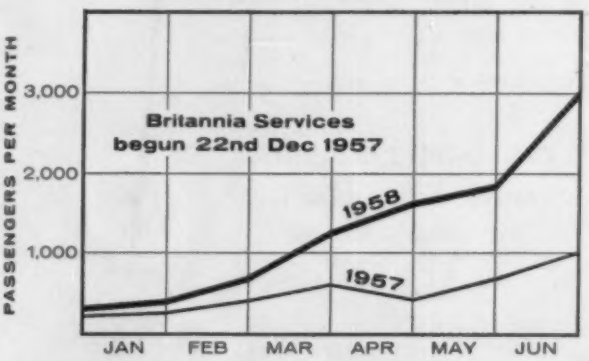
2 Steadily rising utilization rate. Here again aircraft reliability tells. After a year in service with BOAC, Britannia 100 series were achieving 8 hours per aircraft per day and are now flying more than 10 hours—



3,780 hours per annum. After eight months in service with El Al, Britannias were already achieving 8.4 hours per day.

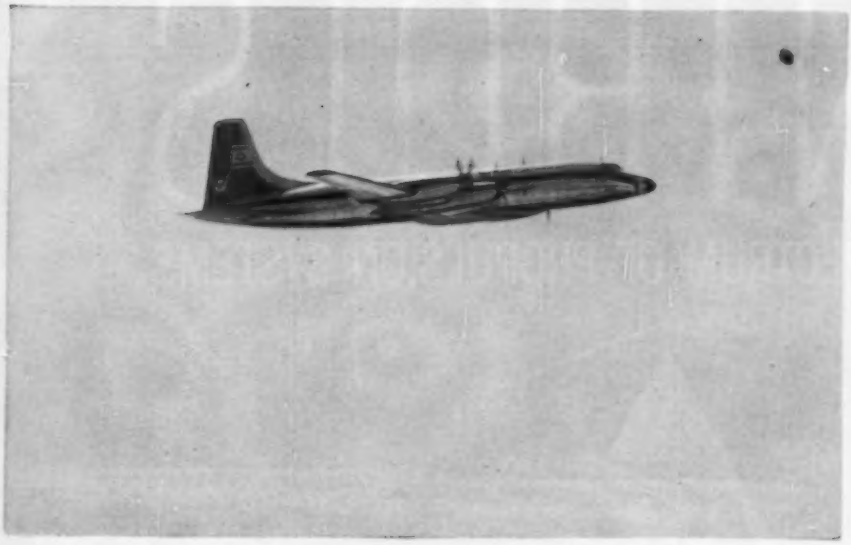
3 Attracting new traffic. On transatlantic routes this year Britannia operators have achieved some of the highest load factors ever recorded—despite a substantial drop for all carriers. During the first 6 months, BOAC's Britannias were 80.2% full.

EL AL TRANSLANTIC PASSENGERS



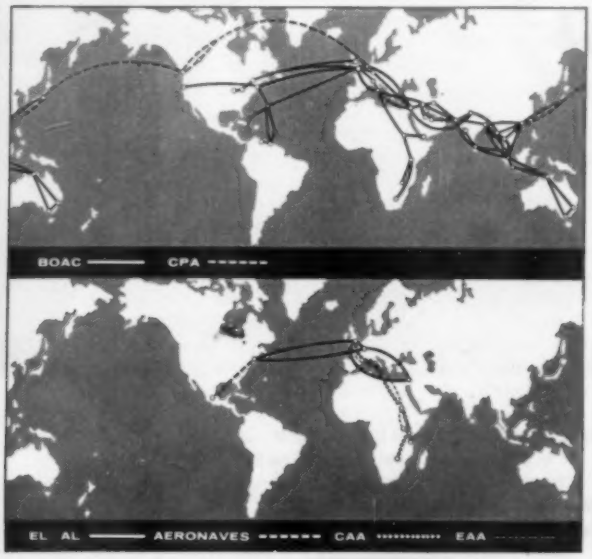
Since introducing Britannias, El Al have trebled their share of transatlantic traffic, while Canadian Pacific on their transpolar Vancouver – Amsterdam route gained a 32% increase in westbound traffic over the same period last year.

On commonwealth routes, Britannias have flown 420 million seat miles, 296 million passenger miles—a load factor of 70%.



THE OPERATORS?

4 Flexible. Britannias fly on stage lengths varying from 300 to 5,000 miles. Routes include: with BOAC, London – New York – San Francisco, London – Montreal – Chicago – Detroit, London – Bermuda – Caracas, on African routes to Johannesburg, and on the Far East routes to Tokyo, Sydney, Melbourne; with El Al Israel Airlines, Tel Aviv – New York, calling at Paris, London; with Aeronaves de Mexico, Mexico City – New York; and with Canadian Pacific Transpolar, Vancouver – Amsterdam, and Trans-Pacific, Vancouver – Tokyo – Hong Kong. Britannias also fly on many other routes for the various airlines.



5 Non-stop transatlantic regularity. During the first six months of this year, El Al scheduled and made 183 transatlantic crossings. Only once did extra severe headwinds force an intermediate stop.

This 100% regularity continued when El Al were operating as many as five return services a week between Tel Aviv and New York *with only three aircraft*. El Al has recently taken delivery of a fourth Britannia; services are to be still further increased.

On their exacting Commonwealth routes BOAC have achieved 98% regularity.

All these factors add up to—
PROFITABILITY

The sum total of success in all these factors is contained in one word: profitability.

El Al's experience bears this out. Their Britannias are operating at a ton/mile cost approximately 20% less than any previously experienced.

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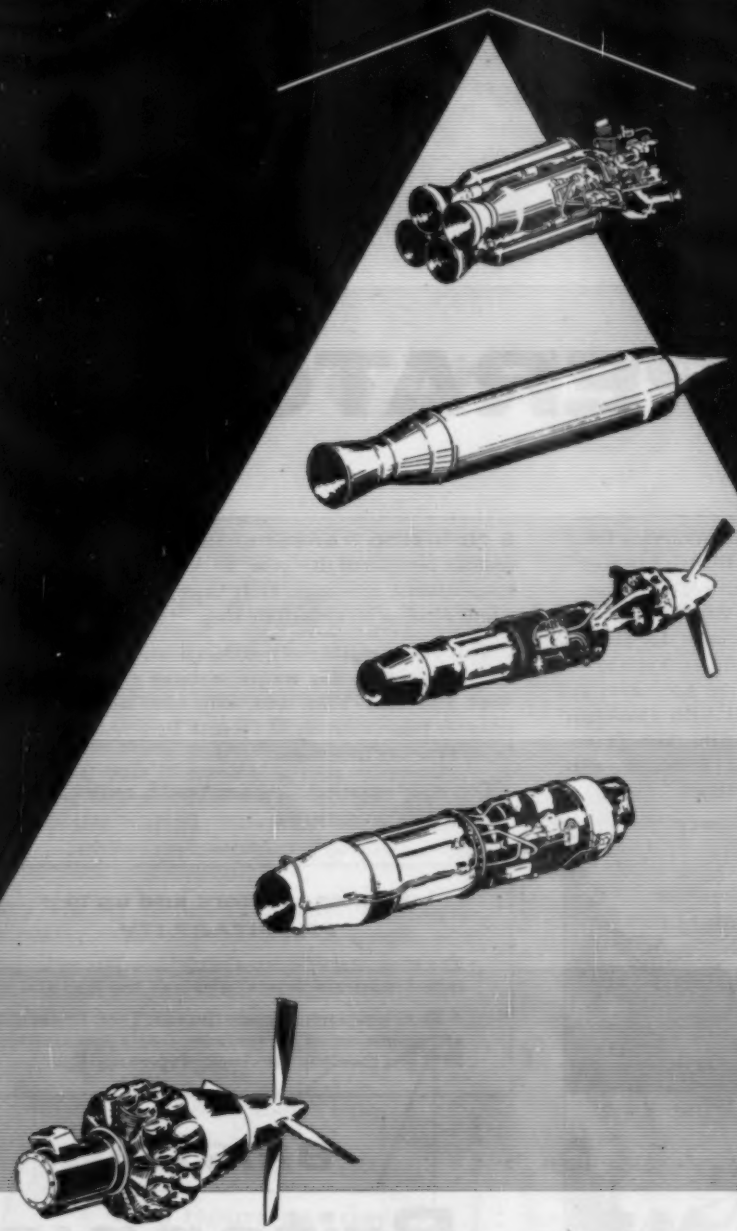

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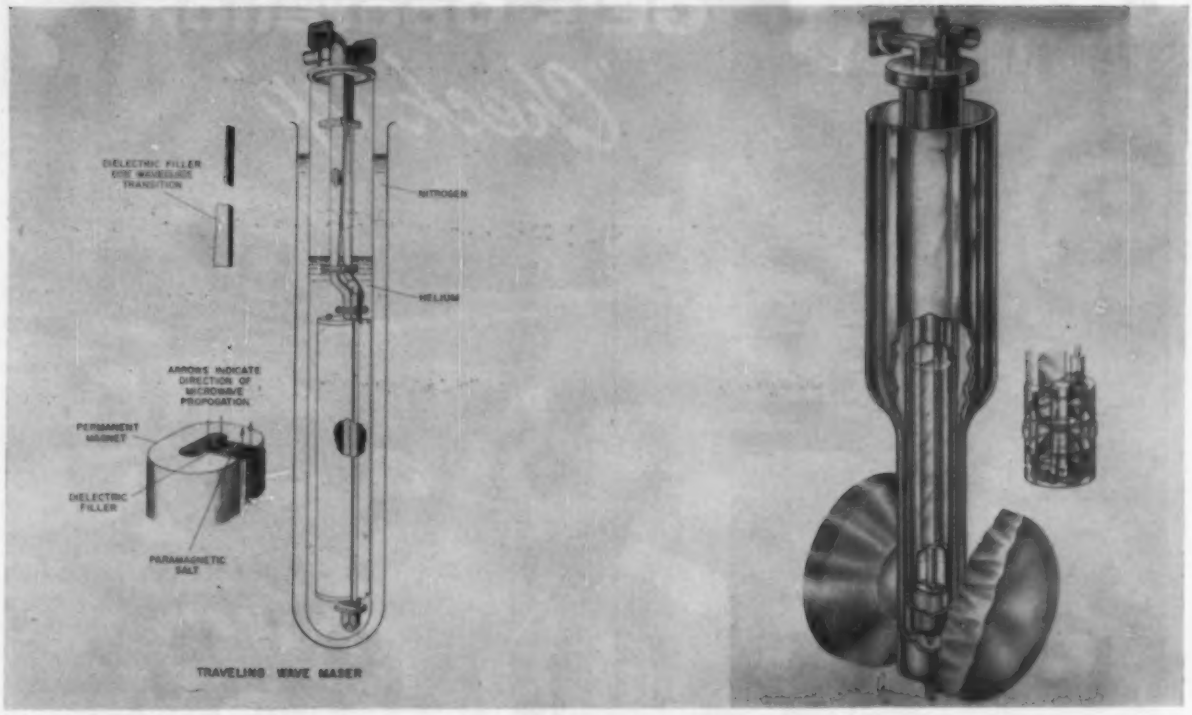

THREE-LEVEL Maser amplifier construction is shown for S-band devices of two different types developed by Lincoln Laboratory. The device at left employs traveling wave principles. Unit at right is a single-crystal device. The new devices have extremely low noise levels.

Boom Predicted for Molecular Amplifiers

By Philip J. Klass

Washington—Impressive variety of Masers, parametric and other molecular amplifiers whose extremely low noise characteristics promise major improvements in the performance of radar, infrared and communication systems, are under intensive investigation and development by more than a dozen avionics manufacturers and research laboratories.

This was disclosed here during the Molecular Electronics Symposium sponsored jointly by Air Force's Air Research and Development Command and the National Security Industrial Assn.

The symposium revealed the widespread interest and activity which has pushed the new molecular amplifiers from scientific curiosities to early experimental hardware in two short years and is reminiscent of the tremendous enthusiasm which followed the development of the transistor 10 years ago. The molecular amplifier appears to be at roughly the same stage of development as the transistor was back in 1951-52.

Unannounced purpose of the symposium was to publicly launch a long-range ARDC program and stimulate industry thinking on the development of fundamentally new techniques for performing electronic functions that will provide order of magnitude improvements in reliability and reductions in size and weight to meet the needs of supersonic aircraft, missiles and space vehicles. USAF's program objectives were first revealed by AVIATION WEEK last June 2 (p. 64) and June 16 (p. 243).

Contract Not Announced

However, ARDC spokesmen were unable to announce an Air Force award of a $7 million research and development contract in molecular electronics because the contract had not been made final by the time of the symposium.

Symposium program was dominated by papers on Masers and parametric amplifiers, many of them dealing in high-powered physics of more interest to physicists than to engineers. While these devices typify the sort of performance advances that can be achieved by fundamentally new solid-state techniques, the program papers left many of the 250 attendees wondering if the symposium was not mistitled.

Maj. Gen. M. C. Demler, USAF director of research and development, called for "dramatic and revolutionary developments" to accomplish Air Force's mission. Col. C. H. Lewis, director of Aero-Electronics, ARDC headquarters, warned that a point of diminishing returns has been reached in attempting to further miniaturize conventional avionic components and equipment. He called for basic research on electronic phenomena and its relationship to chemical, physical, structural and molecular properties so that materials can be created to perform any desired function that now requires collection of interconnected components. Under such a philosophy, "circuits and passive components as we know them today would disappear and be replaced by functional monolithic blocks which are fabricated by growing or etching processes," Col. Lewis said.

Such techniques could reduce the size of avionic equipment by a factor of more than 10:1, weight by more than 20:1, provide up to 37,000 "functions per inch," Lewis predicted.

Symposium speakers reported that the three-level Maser appears to have a clear-cut edge over the two-level Maser for most applications because the for-

GE's Operation "Check-up"

New General Electric Flight-Test hanger at Edwards AFB houses technical and engineering services for aircraft maintenance, instrumentation, data reduction, operations control, quality control, advanced design, etc. Planes shown include the Vought Regulus II Missile, North American F-86, Boeing B-47, Lockheed F-104, Grumman F11F-1F, Douglas XF4D, and the McDonnell F-101.

...at EDWARDS AFB!

At flight test centers like this, General Electric technical and engineering services quickly gather and interpret experimental flight data to guide design toward peak performance for the engine-airplane combination.

Operation "Check-Up" enables the men at General Electric's Jet Engine Department to design, develop and improve jet engines like the J47, the J79, and the new J93—engines which write history.

Headlines like "Speed Record Added to Feats of F-104"—"CJ-805 to Power Convair's New Jetliner"—"Starfighter Sets New Altitude Mark"—"New Air Force Bomber, Fighter Will Shoot for Mach 3" reaffirm the sky-mastery of GE jet power—the mastery established by J47-powered Sabrejets over Korea.

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GE's Operation "PIONEERING"

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mer can operate on a continuous-wave basis. For discussion of Maser fundamentals, see AVIATION WEEK, Aug. 19, 1957 (p. 76) and Aug. 26, 1957 (p. 91). A two-level Maser, however, can operate at frequencies above the X-band whereas present three-level devices cannot, Dr. J. G. Castle of Westinghouse Electric pointed out. Two-level device also is extremely useful for investigating the properties of new materials and as a low-noise source of extremely high frequency microwave energy, Castle said. Both types of Masers require cooling to extremely low temperatures, which tends to limit them to ground-based applications where size and weight are not critical factors.

Silicon Diodes

In the area of molecular amplifiers which can operate at room temperatures, a new parametric amplifier using silicon diodes (AW Aug. 4, p. 69) appears considerably more promising than the ferrite amplifier, according to A. G. Fox of Bell Telephone Laboratories. Although ferrite amplifier has Q's of several thousand, compared to Q's of only 10-20 for diode amplifier, the ferrite amplifier is apt to oscillate at some unexpected frequency due to acoustic vibrating modes which are not yet fully understood, Fox reported.

The diode type of parametric amplifier also was favored by Dr. Leon S. Nergaard of Radio Corp. of America. Because noise figure of such an amplifier depends upon the ratio of signal frequency to idling frequency (the latter is equal to the difference between pump frequency and signal frequency), use of simple diode amplifier is limited by difficulty of obtaining sources of extremely high frequency pumping power.

One way around this limitation is to make use of non-linearity of diodes to generate harmonies of the pumping power which makes it possible to achieve effective pumping frequency that is two or three times the actual frequency, Nergaard said. RCA has demonstrated this technique with diode amplifiers operating at 200, 380 and 6,000 mc. Sylvania's Dr. E. N. Skomal described the use of ferrite or garnet as a harmonic generator (without gain) which can be used to produce extremely high frequency power.

Number of Maser, parametric amplifier programs currently being sponsored by Army's Signal Corps were briefly described by Morris Katzman. They include:

- **Bell Telephone Laboratories** is working with Maser employing ruby crystal. Device has exhibited 23 db. gain with a 25 mc. bandwidth and can be tuned over a 350 mc. range, Katzman said.
- **Radio Corp. of America** is investigating paramagnetic materials including ruby that is doped with chrome, as well

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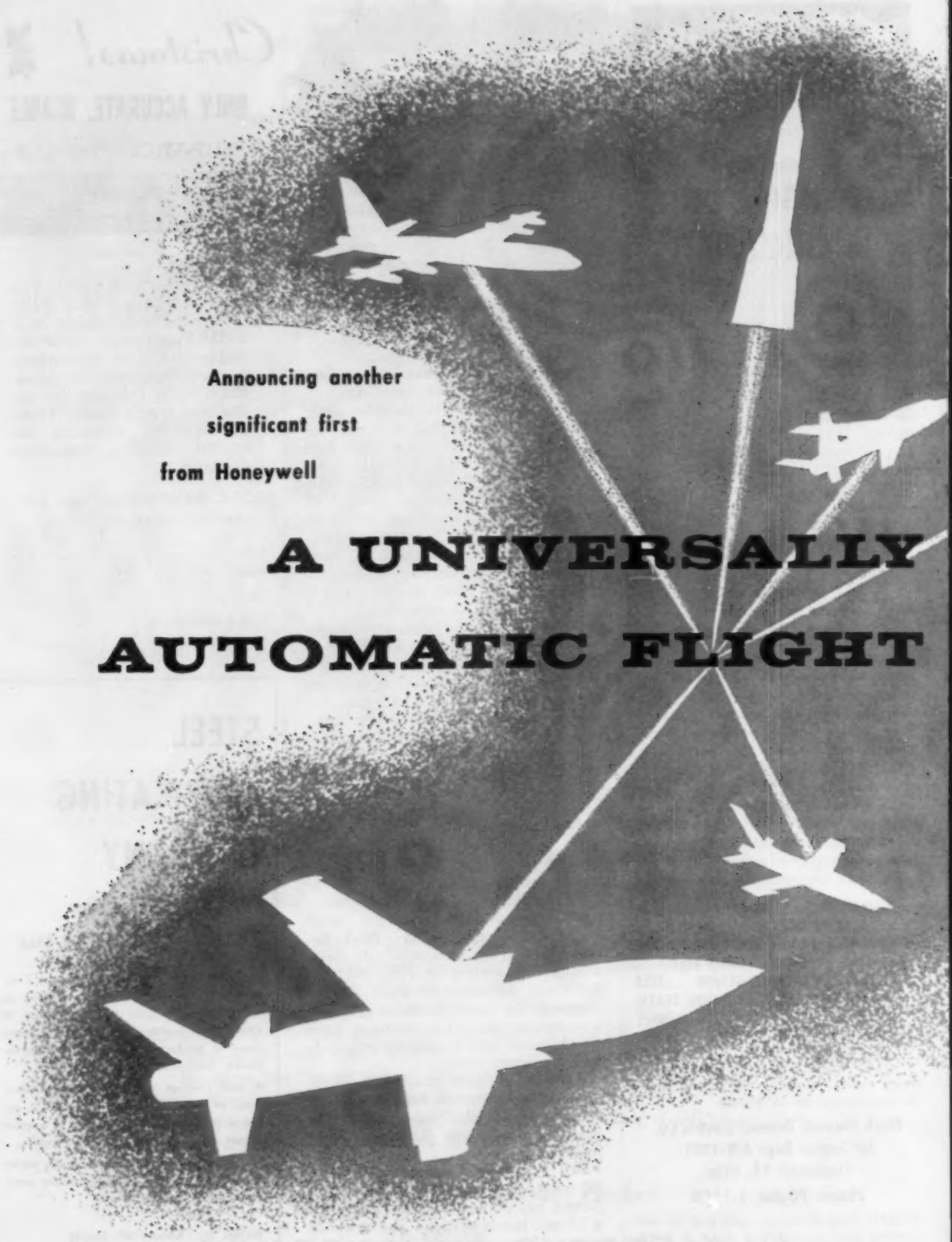
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as use of magnetostriction for Maser tuning.

• **Massachusetts Institute** of Technology is investigating two and three-level Masers.

• **Stanford Research Institute** is working with two-level garnet (ferrite) amplifier and traveling wave types with helix wound around ruby crystal. Katzman said the institute expects to be able to develop a device capable of handling "many tens of kilowatts of peak power."

• **Varian Associates** is studying paramagnetic materials, including strontium titanate doped with iron.

• **Signal Corps** itself is investigating two and three-level Masers.

• **Hughes Aircraft,** working under Signal Corps sponsorship and with its own funds, has developed a two-level ruby Maser that operates at X-band. Hughes also is designing a compact three-level unit for Signal Corps which is expected to have an over-all equivalent noise temperature of 30 deg. Kelvin, half of which comes from Maser crystal itself. Hughes is investigating hydrated salts and other Maser materials, Dr. T. H. Maiman reported.

New Materials

University of Michigan's Willow Run Laboratories, under Army and Air Force sponsorship, also is investigating a variety of new Maser materials, including gallium oxide doped with chrome and irradiated green sapphire doped with vanadium, according to Dr. C. Kikuchi.

General Electric's Dr. Hsiung Hsu described three novel parametric amplifiers which use internal feedback circuits that enable them to operate with pumping frequency that is considerably lower than signal frequency, instead of the usual reverse relationship. Dr. Hsu reported one unit had operated with S-band signal frequency. By changing the amount of feedback, it is possible to increase device's gain, decrease its bandwidth.

Other papers, or comments from members of the audience, indicated that Air Force Cambridge Research Center, Naval Research Laboratory, Harvard University and Airborne Instruments Laboratory are also active in molecular amplified field.

Lincoln Laboratory's Dr. James W. Meyer warned that the "recent burst of activity in the application of paramagnetic materials to solid state Masers has all but exhausted the reservoir of fundamental knowledge built up for us by researchers." He called for expanded and continuing research into properties of new materials.

Dr. Meyer also emphasized that use of extremely low-noise Masers makes the environmental noise of the rest of a radar or communication system, for-

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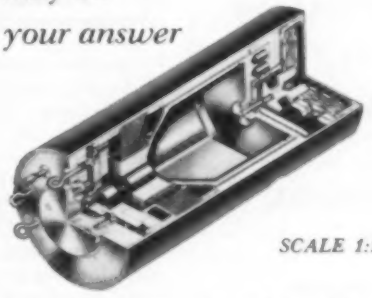

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merly small compared to pre-amplifier noise, of major consequence (AW Aug. 26, 1957, p. 104.) This means that resistive losses in antennas and transmission lines must be held to extremely small values if they are not to offset Maser gains.

Dr. Harvey Brooks, dean of the Harvard School of Engineering and Applied Physics, said progress and understanding in molecular electronics would require investigations in five basic areas:

- **Materials**—preparation and properties.
- **Use of ultra-high magnetic** fields.
- **Bridging gap of knowledge** between microwaves and infrared in electromagnetic spectrum.
- **Micro-acoustics**—the study of sound at microwave wavelengths.
- **Extension of high pressure** techniques to extremely low temperatures.

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▶ **Countermeasures for A3J**—Problem of finding suitable locations for electronic countermeasures antennas on modern bombers is pointed up by the fact that the Navy's new North American A3J originally required 60 ECM antennas, although number has since been reduced. Principal suppliers of ECM equipment for A3J include: Melpar, Motorola and RCA. North American-Columbus holds ECM system integration responsibility.

▶ **Sylvania Reveals ECM Projects**—Number of interesting-sounding study and development programs in electronic countermeasures have been revealed by Sylvania Electric, including:

- **Plato countermeasures study,** for Army Ordnance Corps, on anti-missile missile system for which Sylvania is weapon system manager.
- **AN/ALQ-6 airborne ECM,** recently developed for Air Force.
- **Frequency-diversity anti-jamming** techniques, for Rome Air Development Center. Company also reports analysis and design study for RADC on System 219L, system for detecting intercontinental ballistic missiles. Sylvania also holds program for terminal guidance system for Army's Nike Zeus anti-missile missile program.

▶ **Protecting Avionics From Shock**—New technique for protecting avionics equipment against missile shock and vibration, which uses multi-layer grid and ⅜ in. Teflon rods embedded in matrix of silicon rubber are described in report by Wright Air Development Center. Report, designated PB 151005, priced at $2.75, is available from Office of Technical Services, Dept. of Commerce, Washington 25, D. C.

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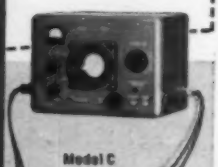

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USAF Traces Ramo-Wooldridge Growth

Washington—Revealing portrait of the Ramo-Wooldridge Corp., financing of its remarkable growth in four years to a $43 million business in 1957 and its relationship to Thompson Products is disclosed in a recently released summary of Air Force Survey of Management of Ballistic Missile Program.

Survey was made early in 1958 prior to the company's decision to separate its Space Technology Laboratories as a corporate entity under James H. Doolittle and to merge the remainder of the company with Thompson Products to become Thompson Ramo Wooldridge Inc. (AW July 7, p. 28; Aug. 25, p. 24).

Report reveals the complex corporate relationship that previously existed between Ramo-Wooldridge and Thompson Products by which its founders sought to retain corporate control while the latter provided the bulk of the company's early financing.

Such details as the names, original and present salaries of all Ramo-Wooldridge employes who earned more than $20,000 annually as of Dec. 31, 1957, also are listed. Report discloses that Air Force has paid Ramo-Wooldridge a total fee of approximately $5.1 million for its efforts on the ballistic missile program from 1953 through the end of 1957. This represents an average of 11% of the $46.7 million in program costs accumulated by the company during this time. Company originally received a fee fixed at 14.3% of estimated cost, but the figure was reduced to 10% in Fiscal 1957, according to the report.

During the four-year period studied, military business represented approximately 97% of Ramos' total, and roughly two-thirds of this came from the company's ballistic missile management efforts. Approximately 60% of the firm's 3,269 employes at the end of 1957 were assigned to the ballistic missile program.

Company's net profit after taxes for the four-year period totaled $5.1 million on total sales of $84.2 million, for a return of approximately 6% on sales. For the year 1957, net profits were $1.9 million on sales of $43.1 million, for a return of approximately 4.4%. The latter is comparable to rates of return achieved by avionics manufacturers.

In the late summer of 1953, Drs. Dean Wooldridge and Simon Ramo left Hughes Aircraft Co., along with other members of the top management, following disagreements with owner Howard Hughes. Wooldridge and Ramo, top two scientists at Hughes, generally are credited with having attracted high-quality scientific personnel to the company in the post-war period who played a major role in its emergence as one of the nation's largest avionics manufacturers.

Wooldridge and Ramo approached J. D. Wright and H. A. Shepard, top officials of Thompson Products whom they had known previously, to see if their company would be interested in financing a new venture the two scientists proposed to form.

As AVIATION WEEK reported four years ago (Oct. 11, 1954, p. 48): "Ramo and Wooldridge wanted a partner who would provide financial backing, business management assistance, yet not insist upon controlling interest (in the new company) in return. This Thompson Products agreed to. . ."

Initial Capital

The two scientists originally each put up $6,750 and Thompson Products invested $165,000, for which it received 49% interest in the new company while the founders and their key associates retained controlling interest. At this stage, the two founders were thinking of a small organization, primarily devoted to research and development, according to views expressed to friends.

It was not until several months later that the Air Force created its Strategic Missiles Evaluation Committee (SMEC) to review USAF's strategic missiles program as a result of breakthrough in thermonuclear weapons. The new company's small group of top-level scientists was looking for challenging assignments at a time when the newly formed Strategic Missile Evaluation Committee was looking for technical support for its assigned task. This led to a committee contract for Ramo-Wooldridge. This, in turn, led to company's being named technical adviser and systems engineer to Air Force's Ballistic Missile Division in May, 1954, when USAF launched its all-out ballistic missile program.

This called for expansion, and capital, far beyond anything originally envisioned by company founders or Thompson Products. Funds on the order of $20 million would be required during the next year or two.

Thompson Products could easily justify a modest $165,000 investment without controlling interest to its own stockholders, but an investment of millions of dollars in a company controlled by two "long-haired scientists" was another matter. The principals needed to work out an arrangement which was not only satisfactory to their mutual interests but which also served to protect Air Force interests.

(Air Force had been extremely worried only a year earlier that management walk-out at Hughes Aircraft might seriously disrupt, if not destroy, its sole source of interceptor fire control systems—although these dire consequences did not subsequently materialize.).

In return for additional financing, Thompson Products was granted an option to purchase 70% of the Class B common stock, a class which elected five of the nine-man Ramo-Wooldridge board of directors. (Class A stock, which Thompson Products already held, could elect only four members of the board.) However, the option could not be exercised prior to 1962-64 and had to be exercised in its entirety. (By this time, the ballistic missile program would be well along the road to tactical use.) The option further provided that Thompson Products could acquire a total of 85% of all common stock, including Class A.

Until the 1962-64 option period, a clear-cut majority of the controlling Class B stock (15,167 out of 25,500 shares authorized) was deposited in a 10-year voting trust with Simon Ramo, Dean Wooldridge and Harold George as trustees. This meant that two of the three trustees could elect a majority on the board, thus controlling the company.

This, the Air Force report points out, assured USAF that it "would continue to deal at least until 1964 with the individuals who were the basis for the original source selection."

Out of this arrangement came a capital structure consisting of two types of preferred and two types of common stock. This was the situation as of Dec. 31, 1957:

- **Cumulative preference stock:** Thompson Products paid in $4 million for all of the 40,000 shares authorized at $100 par value per share.
- **Preferred stock:** Thompson Products paid in $350,000 for 3,500 shares outstanding of 4,000 shares authorized at par value of $100 per share.
- **Class A common stock:** Thompson Products paid in $43,312 for 21,656 outstanding shares of 24,000 shares authorized at par value of $1.00 per share. Company was authorized to purchase

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additional shares sufficient to maintain 49% control of all common stock (Class A and Class B) outstanding.

• **Class B common stock:** Total of 22,540 shares outstanding of 25,500 shares authorized, for total of $45,080 paid in. Total of 15,167 shares of those outstanding were deposited in three-man voting trust.

In addition to the $4.4 million which Thompson Products invested by purchase of preferred stock, the company also signed a credit agreement with Ramo-Wooldridge by which it agreed to loan the latter up to $16 million on 10-year notes. As of Dec. 31, 1957, Ramo-Wooldridge had drawn $7.6 million from Thompson Products, owed another $8.5 million on loans obtained from Mellon National Bank & Trust Co. and Bank of America.

As of Dec. 31, 1957, the investors' capital contribution of $4.4 million had expanded to a total shareholders' equity of $9.2 million, of which $4.7 million represented retained earnings, the Air Force report indicates.

Ramo-Wooldridge owned 56% of total floor space used for the ballistic missile program, leased 33%, with the remaining 11% being government owned. Total investment in property, plant and equipment used for the same program was $32 million, of which 58% was Ramo-Wooldridge owned, 28% leased and the remaining 14% government furnished.

Under the original terms of the company's contract with the Ballistic Missile Division, the company was specifically excluded from participating as a major hardware supplier in the ballistic missile program, except with the approval of Assistant Secretary of Air Force (Materiel.) Ramo-Wooldridge officials were as insistent as the Air Force on this point, to keep the company above reproach in its technical recommendations. Subsequently, Ramo-Wooldridge was low-bidder for design and fabrication of data processing equipment for use on an inertial guidance system which American Bosch Arma was developing for Titan, and Air Force approval was given. The company also won out over Radio Corp. of America, Eastman Kodak and International Business Machines Corp. for a Rome Air Development Center contract to develop intelligence data handling system for Air Force Lockheed reconnaissance satellite (WS-117L).

However, as the ballistic missile program mushroomed, becoming a major portion of the Air Force budget, Ramo-Wooldridge officials realized that they had cut themselves off from a major portion of the future defense business. The Air Force report says "the future

Air Force Ballistic Missile Timetable

Washington—Major milestones in the Air Force's ballistic missile program, revealed by Summary of Survey of Management of the Ballistic Missile Program, recently released by USAF's Inspector General (AW Nov. 17, p. 34) include the following:

• 1946: Project MX-774, which later evolved into Project Atlas, is awarded to Convair. Project subsequently suffered from "frequent policy changes, funds shortages, major technical obstacles and low priority," the report says.

• October, 1953: Strategic Missiles Evaluation Committee (SMEC) is created to review all USAF strategic missile programs because of a recent breakthrough which indicated feasibility of small hydrogen-bomb warheads.

• February, 1954: Reports by both the Rand Corp. and the Strategic Missiles Evaluation Committee (SMEC) conclude that the Atlas intercontinental ballistic missile can be operational by 1960-62 and call for a new Air Force agency to study the ICBM and manage a reoriented program which should be given highest priority and necessary funds. Rand Corp. earlier had submitted reports which indicated the feasibility of intercontinental missiles and had recommended a "drastic revision" of Atlas program, according to the report.

• March, 1954: The reports receive top-level USAF study, acceptance and authorization to revise performance requirements, assign high priority and establish a highly competent military-technical group within ARDC.

• April, 1954: Office of the Assistant Chief of Staff for Guided Missiles is established with responsibility for control and direction of the ballistic missile program at Air Force headquarters. Scientific Advisory Committee is organized by Dr. John von Neumann to continue work of SMEC group and monitor Atlas program progress.

• May, 1954: Highest Air Force priority is assigned to Atlas program and establishment of a West Coast ballistic missile field office is authorized. Its commander is given authority over all aspects of the program "to include development of a complete weapon system, including ground support and the development of recommended operational, logistic and personnel concepts." Name of field office, established July 1, 1954, was later changed to the Air Force Ballistic Missile Division.

• May 17, 1954: Letter contract of the Ramo-Wooldridge Corp. to "perform technical services and furnish necessary personnel, facilities and materials to conduct "Long-Range Analytical Studies of Weapon Systems" in support of recommendations by SMEC. Ramo-Wooldridge, which was formed in the late summer of 1953 when its two founders left top technical positions at Hughes Aircraft, had provided support to the SMEC group during late 1953 in the course of its ballistic missile study and had recommended a 12-month program of technical evaluation and system analysis of Project Atlas. This, the Inspector General's report points out, coupled with Ramo-Wooldridge's "exceptionally talented group of scientist-engineers and a potential for expansion, its capacity then uncommitted contractually," made the firm "the logical choice to provide the technical management group authorized by the Chief of Staff."

• July 20-21, 1954: After review of the Atlas program, Scientific Advisory Committee concludes that "Convair had not demonstrated required weapon system management capability, that Ballistic Missile Division was not strong enough to direct program effectively and that a decision must be reached to assign systems responsibility to new organization." The Ballistic Missile Division subsequently recommended that it assume over-all weapon system responsibility and that Ramo-Wooldridge provide technical direction and systems engineering. This plan was approved by Air Force officials, including Assistant Secretary of the Air Force for Materiel, Roger Lewis.

• During 1955: Air Force ballistic missile program and Ballistic Missile Division responsibilities are expanded to include an alternate ICBM (Project XSM-68) which became the Titan; the tactical ballistic missile program which is now the Thor IRBM; the reconnaissance satellite, WS-117L, now the Lockheed Sentry; the solid-propellant IRBM, later expanded to the present Minuteman ICBM program, and the early warning portion of ballistic missile defense, subsequently transferred to Air Materiel Command.

The speed with which USAF moved on its Thor IRBM program is indicated by the following chronology:

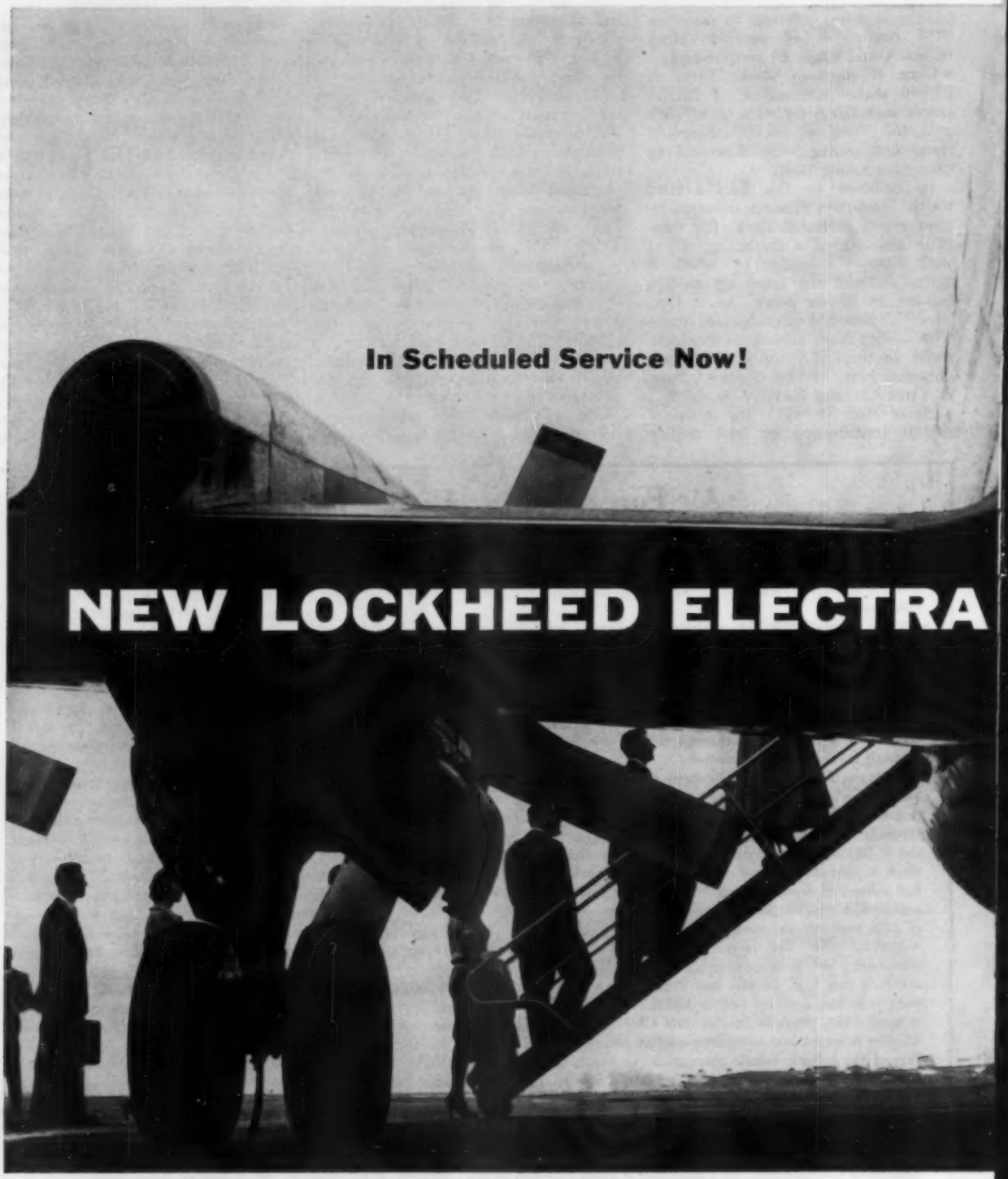
• Nov. 28, 1955: Ballistic Missile Division authorized to proceed with Thor IRBM; contractors notified for proposal briefings.

• Dec. 8, 1955: Proposals for Thor submitted.

• Dec. 23, 1955: Selection of Douglas Aircraft approved by Air Force Secretary Donald Quarles.

• Dec. 28, 1955: Contract for Thor signed with Douglas.

• Jan. 16, 1956: Thor airframe configuration frozen.



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role of the Ramo-Wooldridge Corp. Involved uncertainty because of its expressed desire to participate in the competition for ballistic missile hardware contracts."

This appears to have been major motivation for the recent action in spinning off Space Technology Laboratories (STL) as an independent corporation. STL will be wholly owned by Thompson Ramo Wooldridge Inc., but the latter will have no representation on its board of directors.

Pacific Semiconductors Inc., established in June, 1954, by Ramo-Wooldridge as a subsidiary to develop and produce diodes and transistors, has been unprofitable to date, the report states.

Ramo-Wooldridge and Thompson Products have invested $6.9 million in the form of stock purchases and loans to the PSI subsidiary since its formation. As of last Dec. 31, the company had reported a net cumulative loss of $4.8 million—an indication of the current cost of getting into the highly competitive semiconductor business.

All of the common stock in PSI was owned by Ramo-Wooldridge, with Thompson Products holding preferred which was convertible into common stock after July, 1958, and which, after conversion, would give Thompson Products the right to elect three of the six-man board of directors. As of Dec. 31, the subsidiary had a $3.8 million loan outstanding from Thompson.

In the process of assembling a staff of technical people, Ramo-Wooldridge used all possible inducements, including money, to attract scientists. (The company at that time was frequently criticized in industry circles for its liberal salary policies.)

With this background in mind, the salary figures released in the Air Force report appear surprisingly modest for top-level scientists in today's market. Only 31 out of 616 Ramo-Wooldridge scientists working on the ballistic missile program were reported to be earning $20,000 or more per year on Dec. 31, 1957. This does not include 12 company officers, including Ramo and Wooldridge, and nine other scientists in other Ramo-Wooldridge divisions whose 1957 income also exceeded $20,000.

Wooldridge and Ramo, who each drew salaries of $37,500 during company's first year, were listed for salaries of $50,024 each in 1957. Vice President Harold George, who started at $25,000 in 1953, was drawing $42,500 in 1957. Dr. Louis Dunn, former manager of the Space Technology Laboratories Division and now president of Space Technology Laboratories Inc., received a salary of $37,500 in 1957, while Dr. R. F. Mettler, new executive vice president of STL, drew $33,000.

In addition to these salaries, total

bonuses of $71,900 were distributed to key employes in 1957, with no individual receiving more than $15,000. This added compensation was not claimed for reimbursement under the company's CPFF contract with BMD.

Under terms of the recent merger, former Thompson Products President J. D. Wright becomes chairman of the board and chief executive officer, while Dr. Wooldridge becomes president of the combined company. Dr. Ramo retains the title of executive vice president for the merged firm and F. C. Crawford, former board chairman of Thompson Products, becomes chairman of the executive committee.

Merger was carried out through the exchange of 260,376 shares of Thompson Products common stock, representing about 8½% of its now outstanding shares, for 18,790 outstanding shares of Ramo-Wooldridge Class B stock not already held by Thompson Products. The latter already owned all of Ramo-Wooldridge's other classes of outstanding stock. The exchange ratio was 13.85714285 shares of Thompson Products common per share of Ramo-Wooldridge Class B stock. At the current market price of around $65 per share for Thompson Products common, each share of Ramo-Wooldridge stock was worth approximately $904.

At current market price, Ramo-Wooldridge stockholders received approximately $16.9 million for their equity in the company. This figure, Thompson Products told its own stockholders in a recent report, was believed to be "substantially less" than the price it would have been required to pay if it had waited until the mid-1960's to exercise a previous option.

A total of 10,500 shares of the 18,790 outstanding Ramo-Wooldridge Class B stock was held by four Ramo-Wooldridge officers and directors: Wooldridge, Ramo, George and Dr. Ralph P. Johnson. Thompson Products stockholders report reveals that it had acquired 3,750 shares of Ramo-Wooldridge Class B stock since 1955, principally from officers, at prices ranging from $150 to $275 per share.

The report also says that Ramo, Wooldridge and George now are among the largest single stockholders of the merged company, all three with holdings that exceed those shown for Crawford and Wright. Holdings, and approximate market value, for the four Ramo-Wooldridge officials are:

- **Dr. Simon Ramo:** 48,499 shares; $3,152,435.
- **Dr. Dean Wooldridge:** 45,035 shares; $2,927,275.
- **Harold George:** 38,107 shares; $2,476,955.
- **Dr. Ralph Johnson:** 13,857 shares; $900,705.

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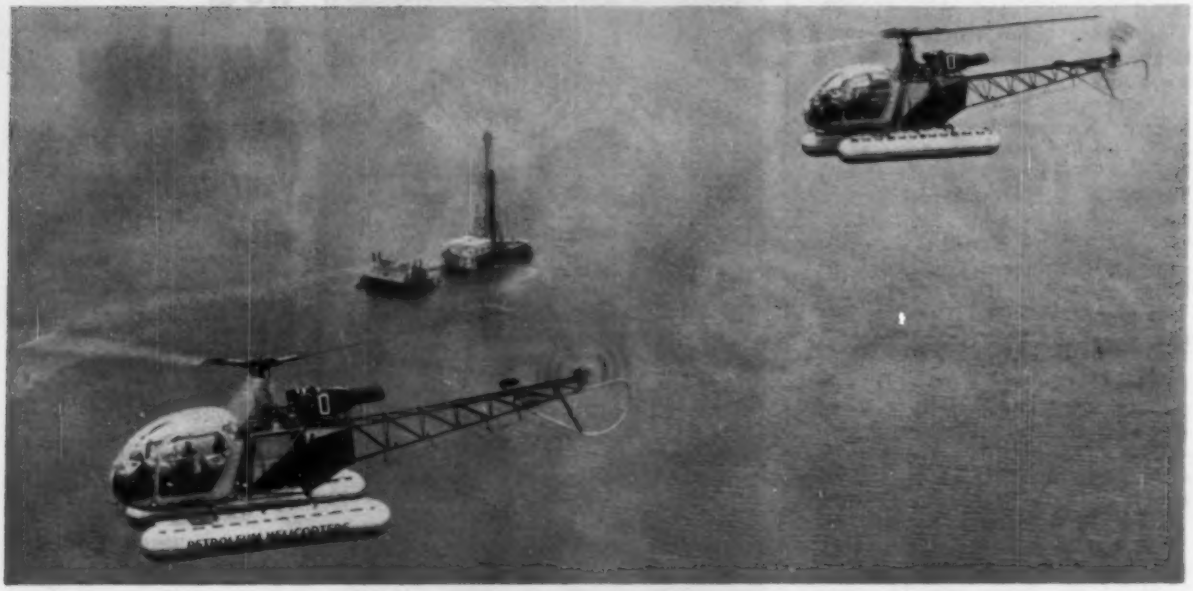


ALOUTTES owned by Petroleum Helicopters, Inc., have carried more than 1,000 passengers to and from offshore oil rigs since June.

Alouette Gains Stature in Offshore Use

By Erwin J. Bulban

New York—Initial performance of a pair of French-designed Sud Alouette turbine-powered helicopters on the job for the offshore oil industry in the Gulf of Mexico is leading to fast-spreading acceptance of the relatively new rotary wing aircraft by this very critical customer.

Indications are that by the end of next year some dozen "Whistlers," as they are nicknamed, will be working in this area.

This prediction comes from veteran helicopter operator Robert Suggs, president of Petroleum Helicopters, Inc., which has a fleet of approximately 30 Bell 47s working in the Gulf area and in South America. Petroleum Helicopters took delivery of its first Alouette June 19 and the second on Aug. 22, and is considering eventually replacing its Bells in this area with the newer, faster Alouette.

First Commercial Purchaser

Petroleum Helicopters is also likely to be the first commercial purchaser in the U.S. of the Sud Djinn two-place tip burning helicopter, also marketed here by Republic Aviation Corp. under licensing agreement with the French manufacturer. The company plans to use these on hauls between oil rigs anchored 70-80 mi. out in the Gulf, replacing Bells now based there. Suggs also is studying use of the Djinn in aerial agricultural operations; a demonstration of this capability was provided him at the factory during a recent trip to New York.

Key factors in what Suggs terms "universal acceptance" of the Alouette by the oil industry include:

• **Speed,** the Alouette providing airspeed of some 90 mph. on 70-mi. flights from land base to the rigs, of which 50 mi. is over water, compared with 60-65 mph. for the Bell 47. Psychological factor of reducing the time passengers spend over water has been a most important reason he favors the new turbine-powered helicopter, Suggs told AVIATION WEEK.

• **Alouette, being larger** than the Bell 47, has the appearance of being more rugged, according to customer comments, and the French machine's more powerful turbine engine also has been the subject of remarks by passengers, who say that they favor the Alouette over the Bell, according to Suggs. Thus far, with only two Alouettes in his total fleet, most of their use has been in transporting industry executives and engineers. Suggs reports that requests for transportation to or from the rigs usually specify that a "Whistler" be available instead of a "Bubble," which is the nickname for the 47.

• **Fuel availability** is another important factor in the Alouette's growing popularity. Oil companies, very conscious of fire hazards on their operations, refuse to permit storage of any aviation fuel aboard their rigs, which necessitates cutting payload of piston-powered aircraft since they must carry enough fuel for a round trip. However, kerosene is a common item around this industry's property and the Alouettes can be refueled aboard the rigs if necessary. Bell 47s generally carry two passengers per trip, Suggs reports, often only one, but the Alouette's normal load is three passengers and it can carry four if the aircraft makes a fuel stop "on the beach" just before heading over the water. One oil company has specified the Alouette because of larger capacity, since its operation would require use of two Bells where one Alouette can adequately handle the job.

Customer Cost

Cost to the customer for Alouette service is similar to that for the Bell. Alouette actually has higher operating cost, but because flying time is so much less it can make more trips—and the customer pays by flying hour.

Suggs points out that the Bell 47 has done an extraordinary job in developing and handling the offshore oil industry's large-scale transportation mission, but the Alouette is gaining rapidly in popularity because it is a newer, higher-performance aircraft and presages replacement of many piston-powered helicopters by turbine power in the future. Suggs predicts that in aproximately a year perhaps 75% of helicopter operations in the Gulf area will be handled by turbine-powered Alouettes.

Petroleum Helicopters has put in

more than 300 flying hours on its number one Alouette since delivery in June, almost that much on the second ship. Aircraft are averaging approximately 3½ hr. a day. From delivery time to the end of October, ship number one had accumulated 292 flying hours on 340 flights and carried 531 passengers plus cargo. Availability record was 84%. Ship number two at the end of this period had flown 262 hr., made 161 flights and carried 474 passengers plus cargo. Availability was 95%.

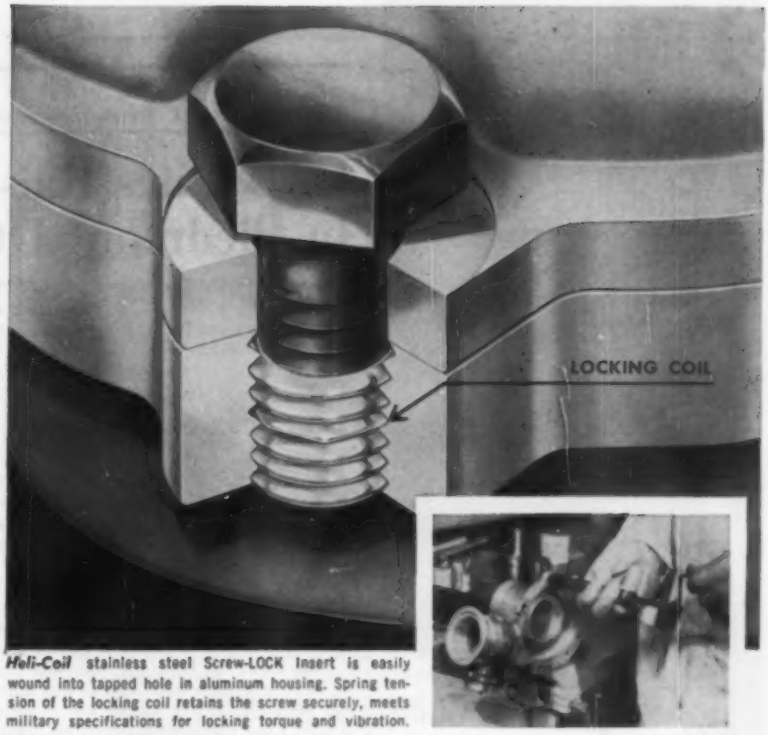
Maximum distance of flights has been 138 naut. mi. and maximum endurance time 1 hr. 50 min. Suggs reports that of 208 days the Alouettes have been available, they were not used for a total of 26 days for both aircraft due to weather, maintenance and similar reasons. Ships have been averaging 88% availability; he expects this to go up as his maintenance staff's learning curve improves.

One Alouette flew 130 hr. in 30 days covering 10,400 naut. mi. and on one typical mission carried 700 lb. of cargo 71 naut. mi. in 53 min., he notes. Helicopter made landings and takeoff from oil rigs in winds exceeding 35 kt.

Suggs said that the aircraft probably could have shown even higher availability in initial operating period except for an extra safety factor Petroleum Helicopters used while it learned how to handle the new aircraft. For example, if the slightest problem came up regarding a line check or maintenance, the Alouettes would be "stood down" and a Bell substituted for that flight.

Suggs also pointed out that carburetor icing inherently is no problem with the turbine-powered helicopter, while on a piston type, need for application of heat also results in subsequent power losses. Control simplicity (no throttle is used) is another feature; pilots turn turbine up to maximum speed, maximum fuel, which is the most efficient condition for the Alouette and provides it with the most useful payload.

Petroleum Helicopters maintains a 30-day level of spares—Republic is providing it with 24-hr. service on needed parts, he stated. Company has a powerplant exchange program where if the operator gives Republic 48 hr. notice, it can have a zero-time engine at Petroleum Helicopters' Morgan City, La., base with time to spare. Engine carries 50-hr. warranty. Engine changes take approximately 30 min. Alouette's Turbomeca powerplant currently has time between overhauls of 310 hr., formerly 260 hr., and this is expected to go to 350 hr. soon. Main rotor blades, formerly requiring replacement at 600 hr., now go to 1,200 hr.; tail rotor, which formerly came off at 300 hr., can go 2,500 hr.



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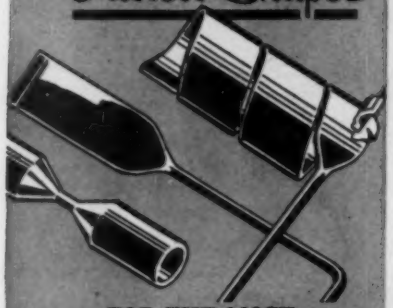

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SAFETY

CAB Accident Investigation Report:

CAB Cites Raised Gear Latch In Piedmont DC-3 Accident

On Oct. 2, 1957, at approximately 1211[1], the landing gear of a DC-3 collapsed as the aircraft was being taxied to the ramp. The aircraft, which was leased to Piedmont Airlines by the U. S. Navy Dept., sustained substantial damage. No one was injured.

HISTORY OF THE FLIGHT

N 3947A departed Washington, D. C., at 1130 as Flight 85. Its destination was Knoxville, Tenn., with intermediate stops scheduled at Charlottesville, Lynchburg, and Roanoke, Va.; Bluefield and Princeton, West Va. and Tri-Cities, Tenn.

The gross takeoff weight was 23,845 lb., well under the maximum allowable of 25,346. The load was correctly distributed within the allowable center of gravity limits.

The flight to Charlottesville was made in VFR weather conditions and was routine and uneventful. The copilot was flying the aircraft from the right seat and the captain was performing the duties of copilot. As the flight approached Charlottesville the wind was determined to be southerly and the crew elected to land on runway 21. A normal landing and rollout was made with the copilot still handling the flight controls.

After the landing roll was complete, the aircraft was turned around on the runway and taxied approximately 300 ft. to a taxiway. A 90-deg. right turn was then made and the aircraft taxied an additional 531 ft. As the aircraft approached the ramp the captain took over the controls. At this time both main landing gears collapsed. No fire occurred; however, the aircraft sustained substantial damage.

The crew and the 14 passengers deplaned immediately.

INVESTIGATION

The cockpit of N 3947A had been secured by the crew immediately following the accident. Inspection revealed that the landing gear elector valve handle was in the NEUTRAL position. The mechanical latch was locked in the POSITIVE LOCK position. The hydraulic fluid level in the right gauge was normal. The hydraulic system pressure gauge indicated 750 lb. pressure and the landing gear pressure indicated zero. When the battery master switch was turned on, the landing gear warning light indicated a red or unsafe gear condition. The landing gear warning horn properly sounded when the throttles were retarded past a point about one-third of their full travel.

Each main landing gear on the DC-3 consists of a wheel assembly mounted between two shock absorber struts which are attached to a truss. The truss is hinged to allow it to retract or extend the wheel when hydraulic pressure is directed to the proper side of an actuating strut. The upper end of this strut attaches to the nacelle structure and the lower end attaches to the movable truss on the landing gear. When the landing gear selector handle in the cockpit is moved, hydraulic pressure is directed to the actuating strut which either extends or retracts, thus actuating the landing gear.

A spring-loaded safety latch is installed in each nacelle on the forward face of the front spar. When the landing gear is fully extended the latches engage a hook slot at the lower end of each actuating strut piston, thereby locking the landing gear in safe landing position to the front spar.

The latches are controlled simultaneously through a system of cables and pulleys operated by a single control handle on the floor in the cockpit. The latch control system is connected by levers to a catch on the landing gear selector handle in such a manner that the latches must be raised manually before the landing gear selector can be moved to the UP position to retract the gear.

Lock Operation

The safety latch control has three positions: UP LATCH, SPRING LOCK, and POSITIVE LOCK. When the control is moved to the UP LATCH position, the safety latches (spades) in the nacelle are raised clear of the hook slots on the ends of the actuating struts. The gear can then be retracted by raising the landing gear selector handle to the UP position. When the selector handle is returned to NEUTRAL, the latch control handle automatically moves to the SPRNG LOCK position. In this position the safety latches are returned to the full down position and are held in place by spring tension. As the gear extends, the hooks on the ends of the actuating struts raise the latches which are then dropped into the hook slots by the spring tension when the gear is fully extended.

When the latch control is placed in the POSITIVE LOCK position a cable actuated piston exerts a pressure of 100 lb./sq. in. on the latches, which prevents them from being withdrawn from the hook end slots.

Several signal systems are incorporated into the landing gear mechanism. A warning horn operated by microswitches sounds whenever either or both throttles are closed, if one or both wheels are retracted or unlatched, or if the landing gear selector handle is not in the NEUTRAL position. Warning lights are operated by a switch connected to the landing gear selector handle. This switch is also connected to the switches on each landing gear. When

[1] All times are eastern standard based on the 24-hr. clock.

both wheels are down and locked and the selector handle is in NEUTRAL, a green light comes on in the cockpit. If either wheel is retracted or not locked or the selector handle is not in NEUTRAL, a red light comes on.

If for any reason the safety latches cannot be engaged it is still possible to land and taxi the DC-3 safely. The landing gear selector handle is placed in the DOWN position. When the gear has fully extended and the landing gear pressure has built up equal to the system pressure (750 lb./sq. in.), the landing gear selector handle is returned to the NEUTRAL position. Hydraulic fluid pressure is thus trapped in the down lines against the actuating strut pistons preventing their retraction. In this condition the warning horn will sound and the red light will stay on since both are connected to the safety latches. When brakes are applied the resulting rotative force will have a tendency to cause the landing gear partially to retract, moving the pistons up in the actuating struts and resulting in an increased pressure in the landing gear down lines. If care is not exercised, the increased pressure could become high enough to rupture the down line and allow the gear to collapse.

Latch Undamaged

Examination of the aircraft revealed that the left landing gear was in the fully retracted position and was not damaged. Its mechanical safety latch was found to be undamaged and in the full down position.

The right landing gear was also found in the fully retracted position. However, the inboard side of the wheel axle had broken through the nacelle structure and was forced upwards four inches beyond its normal travel. Its mechanical safety latch was also found in the full down position and undamaged.

When the aircraft was raised the mechanical safety latches were tested. Both were found to be rigged properly and held in the POSITIVE LOCK position under proper cable tension. The mechanical latch cockpit control was then placed in the SPRING LOCK position and the landing gear allowed to fall. The left landing gear locked down with slight hand pressure. The right landing gear fell to the full down position but the mechanical safety latch would not enter the strut end hook slot to lock the gear down.

The right landing gear actuating cylinder hydraulic down line was found to be ruptured. The hydraulic fluid which had been trapped in this line was found in the nacelle and on the pavement directly below the nacelle. It was determined that the rupture of this line resulted in loss of the landing gear hydraulic pressure, allowing the aircraft to settle abruptly. The weight of the aircraft then forced the gear up beyond its normal travel and the severe twisting moment to which it was subjected bent the actuating strut end hook. This slight bend caused a binding which prevented the mechanical safety latch from entering the strut end hook. When the strut end hook was replaced this gear would lock in the down position with slight hand pressure.

After this repair the landing gear was cycled a number of times and it operated

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normally each time. The gear warning system was also checked and all indications were proper and normal during each operation.

A careful inspection of the entire landing gear system showed that it was operating properly. All clearances were found to be within their respective tolerances. Rigging of cables and pulleys was proper and no binding or malfunction could be found. With the exception of the above noted damage, all components of the system were in good condition.

It was determined that all damage noted was the result of the collapse of the landing gear. No mechanical defect or irregularity could be found which could have interfered with the proper operation of the landing gear. In addition, no malfunction in the operation could be induced which would cause the landing gear to operate incorrectly.

The aircraft was then test flown and the landing gear cycled several times. Each time the gear was extended it would lock down properly and the warning system indicated correctly. In several of the tests the mechanical latch handle was placed in the POSITIVE LOCK position before the landing gear was lowered. In every case the strut end hook raised the safety latch against the cable tension of the latch actuating mechanism and permitted the latch to position itself correctly in the strut end hook and thus lock the gear down normally.

The crew stated that the flight had been routine. They said that in preparation for landing at Charlottesville they had followed the usual checklist. The landing gear was lowered and each pilot checked visually to see that the gear on his side extended. The hydraulic pressure was allowed to build up in the landing gear system to 750 lb./sq. in. The mechanical latch on the cockpit floor was then engaged and the gear selector handle was returned to NEUTRAL. Both pilots stated that after the gear was extended the green "gear safe" light indicated the landing gear was down and locked; further, that both throttles were closed on the flareout before touchdown and that if the gear had not been locked at that time the landing gear warning horn should have sounded. At no time during the landing, the rollout, or the taxiing to the ramp did the crew note any indication of an unsafe gear condition. However, simultaneously with the collapse of the gear at the ramp the warning horn sounded and the red warning light came on.

Both pilots were also positive that the gear had been properly extended and locked. Both testified that the landing gear controls had not been moved after the gear was lowered and locked and that no controls were moved after the gear collapsed at the ramp.

ANALYSIS

The landing gear on the DC-3 is relatively uncomplicated in design and its reliability has been proved by many years of successful use. It is also foolproof in operation providing all cables, pulleys, struts, etc., are properly rigged and clearances are correct.

The examination of the landing gear on N 3947A showed that no defect existed in the system prior to the collapse.

Both safety latches were found in the

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POSITIVE LOCK position with the hooks withdrawn. In addition, the safety latch control in the cockpit was latched to the floor. In order for both gears to collapse as they did both safety latches would have had to have jammed in the UP LATCH position. This possibility is extremely unlikely and no evidence was found on either latch mechanism which could have caused a double failure such as this. In addition, the latch spade mechanism is actuated by a cable and pulley arrangement and if one or both of the latches had hung up it would have required considerably greater than normal force to latch the cockpit control. Further, even if by some almost impossible chance one or both latches had hung up and the cockpit control could be properly latched, the red "Unsafe" warning light would have come on in the cockpit and the warning horn would have sounded. This would also have been evident during the examination of the aircraft because for such to have been possible the rigging of the latching mechanism would have had to have been improper. It was not.

It would have been impossible for the landing gear to retract with the safety latches properly engaged in the hook end slots without considerable damage to the latch mechanisms or the hooks. The only damage noted was a slight bend in the actuating strut end hook for the right gear. This damage occurred as the gear twisted when it was forced up beyond its normal travel by the abrupt settling of the aircraft. Here again, even if this damage had been present prior to the collapse it would have been evident. First, if the gear would not lock down, the red warning light would have stayed on and the warning horn would have sounded. Second, the left landing gear would not have been affected and would have locked down safely.

Excessive Pressure

The hydraulic down line which was found ruptured was determined to have burst as a result of excessive pressure. This line could not have failed before the gear was extended for landing. If it had, when the gear selector handle was placed in the DOWN position the hydraulic fluid in the main system would have been lost. When the aircraft was examined the hydraulic fluid level was normal. In addition, a small amount of hydraulic fluid that had been trapped in the down line was found under the aircraft on the ramp, indicating that the line had burst after the aircraft had reached this point.

The failed hydraulic down line also indicates the way this accident happened. In order for the line to have ruptured as it did, the landing gear selector handle had to have been in NEUTRAL with the latches in the UP LATCH position. In any position other than NEUTRAL, excessive pressure, built up as a result of the partial collapse of the gear, would have been relieved through pressure relief valves. Further, if the safety latches had been engaged in the hook end slots the gear retraction would have been prevented by the mechanical latch.

In summary, the Board concludes that for this accident to have occurred in the manner indicated by the crew a number of simultaneous malfunctions would have had to have occurred. First, both safety

latches would have had to hang up and then seat themselves properly after the collapse. Second, the cockpit latch control would have had to have been misrigged and then have corrected itself when the latches were forced to the full down position after the gear had collapsed. Third, the three microswitches operating the landing gear warning system would have had to have not only failed but would have also had to reverse normal functions, giving a green gear safe light instead of a red unsafe light. This condition also would have had to have corrected itself when the aircraft settled. Fourth, the landing gear warning horn would have had to have been inoperative and then have corrected itself.

In the absence of evidence to substantiate any such malfunctions, the Board must conclude that no mechanical failure occurred which even contributed to the cause of this accident.

FINDINGS

On the basis of all available evidence the Board finds that:

1. The aircraft, company, and crew were properly certificated.
2. The flight was routine and no mechanical difficulties were experienced by the crew.
3. According to the crew the landing gear was extended and locked properly as the aircraft was prepared for landing and a green "gear safe" indicator light came on in the cockpit.
4. A normal landing and rollout was made.
5. As the aircraft approached the ramp both main gears collapsed.
6. Several simultaneous malfunctions would have had to occur for the landing gear to collapse while a "gear safe" condition was indicated.
7. Examination showed there was no malfunction in the landing gear, landing gear safety latch mechanisms, or landing gear warning systems.

PROBABLE CAUSE

The Board determines that the probable cause of this accident was that the cockpit landing gear safety latch lever was accidentally or inadvertently moved to the UP LATCH position while the aircraft was being taxied to the ramp.

By the Civil Aeronautics Board:

James R. Durfee
Chan Gurney
Harmar D. Denny
G. Joseph Minetti
Louis J. Hector

SUPPLEMENTAL DATA

The Civil Aeronautics Board was notified of this accident on the afternoon of Oct. 2, 1957. An investigation was immediately initiated in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. Depositions, ordered by the Board, were taken in the CAB offices in Washington, D. C., on Nov. 12, 1957.

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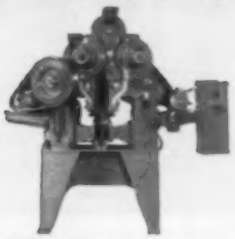

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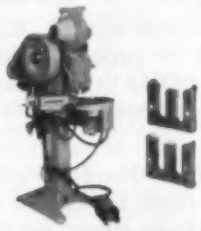

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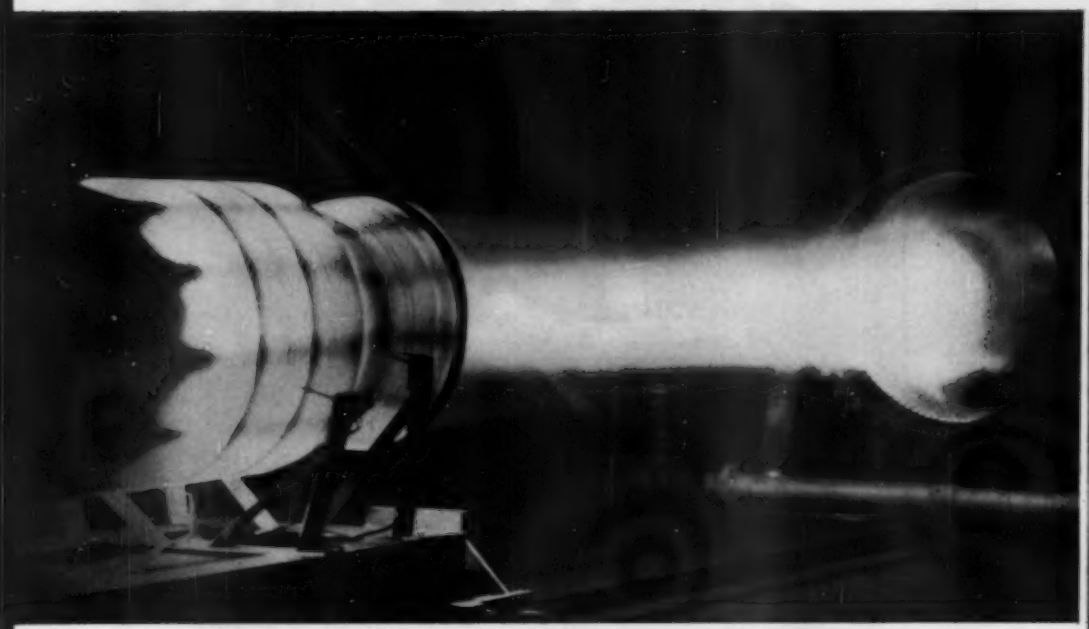

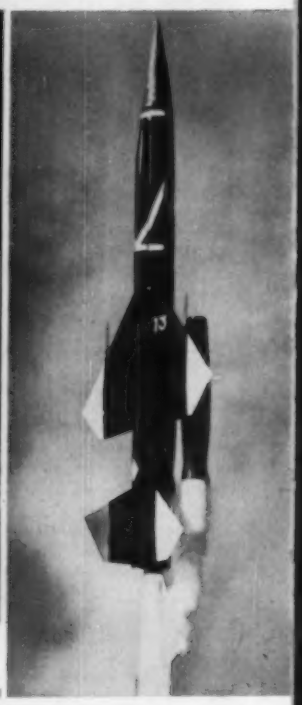

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with its principal offices in Winston-Salem, N. C. In December, 1947, the company established the Piedmont Airlines Division. The company operates under a currently effective certificate of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration. These certificates authorize the company to transport by air persons, property, and mail between various points in the continental U.S., including the route involved.

FLIGHT PERSONNEL

Capt. Howard Coe Kelly, age 43, was employed by Piedmont Airlines, Mar. 22, 1948. He had accumulated a total of 12,110 flying hours, of which 8,282 were in DC-3 equipment. Capt. Kelly held a valid airman certificate with an airline transport rating and type rating in the DC-3. His latest six-month proficiency check was May 28, 1957, and his last en route check was April 24, 1957. He had passed his CAA physical May 20, 1957. Capt. Kelly had flown 46 min. in the preceding 24-hr. period and 2 hr., 28 min. total in the preceding seven days.

Copilot Fred Kozak, age 29, was employed by Piedmont Airlines Mar. 17, 1953. He held a valid airman certificate with commercial privileges, airplane single-engine land, and instrument ratings. Mr. Kozak had a total of 2,095 flying hours, of which 1,871 were in the DC-3. His latest copilot proficiency check and instrument certification was in August 1957. His last CAA physical was passed Jan. 25, 1957. Mr. Kozak had flown 46 min. in the preceding 24-hr. period and nine hours, four minutes total in the preceding seven days.

THE AIRCRAFT

Douglas DC-3C, N 3947A, company identification 58V, manufactured January, 1944, was owned by the U. S. Navy Dept. and leased to Piedmont Aviation Inc., Winston-Salem, N. C., the operator. It had a total of 7,780 flying hours, and a total of 3,929 flying hours since overhaul. The total time on the landing gear was 7,780 and the total time since the No. 4 maintenance check, when the last landing gear retraction test was performed, was 639. Several minor landing gear discrepancies were corrected at that time. The landing gear rigging and microswitches were inspected and passed on the last No. 2 inspection performed Sept. 21, 1957. The aircraft had flown 64 hr. since that check. The aircraft was equipped with Pratt and Whitney engines, model R1830-92, and Hamilton Standard propellers, model 23E50.

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Boeing Airplane Co.'s last B-52F has been rolled out of the Seattle Division plant, ending production of B-52s in Seattle. B-52G missile platform series is being built at Boeing's Wichita plant.

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WHO'S WHERE

(*Continued from page 23*)

Changes

Dr. Frank J. Lavacot, director, research and development, McCormick Selph Associates, Hollister, Calif.

Gerald E. Kerr, manager, application engineering, Statham Instruments, Inc., Los Angeles, Calif.

General Electric's Defense Systems Department, Syracuse, N. Y., has appointed the following section managers: **Warner R. Sinback**, marketing operations; **Walter B. Booth**, employee relations; **John K. Records**, ground and information systems engineering; **Gen. Haywood S. Hansell**, defense evaluation operation (Washington, D. C.); **Richard C. Raymond**, technical military planning operation (Santa Barbara, Calif.); **Curtis G. Talbot**, flight test operations (Schenectady, N. Y.); **Walter A. Hahn, Jr.**, systems management research operations; **Donald L. Johnson**, manufacturing operations.

William D. Fritz, senior mechanical engineer, instrument development section, Datex Corp., a subsidiary of G. M. Giannini & Co., Inc., Monrovia, Calif. Also: **John L. Kent**, advertising and public relations manager of Datex.

The following appointments have been made in the Electronics Division of Stromberg-Carlson, a division of General Dynamics Corp., Rochester, N. Y.: **Frederick S. Mitchell**, chief engineer-industrial products; **William J. Stolze**, manager-technical staff; **Leslie D. Catlin**, manager-engineering services.

John W. Wolcott, III, sales manager, Special Products Division-Aviation and Missile Group, The Weatherhead Co., Cleveland, Ohio.

Martin Cooperstein, head-fire control department, Missile Systems Laboratory, Sylvania Electric Products, Inc., Waltham.

Frank J. Lavelle, assistant sales manager, Sperry Microwave Electronics Co., a division of Sperry Rand Corp., Clearwater, Fla.

Philco's Solid State Electronics Research Department, Philadelphia, Pa., has appointed the following managers in the semiconductor field: **Dr. Charles H. Sutcliffe**, component development; **Dr. James B. Angell**, circuit research; **Dr. Marvin E. Lasser**, applied physics research; **Edmundo Gonzalez-Correa**, research planning.

Charles H. Lilly, liaison engineer for the Old Forge, Pa., Manufacturing Division of The W. L. Maxson Corp., New York, N. Y.

Merton R. Fallon, manager-field service engineering, Minneapolis-Honeywell's Aeronautical Division, Minneapolis, Minn.

Adm. B. Hall Hanlon (USN, ret.) consultant-research and development, Magnavox Co., Fort Wayne, Ind.

Robert K. Leary, manager, applications engineering, Customer Relations Department, Stratos Division, Fairchild Engine & Airplane Corp., Bay Shore, N. Y.

Charles C. Snider, director of sales, Consolidated Electrodynamics Corp., Pasadena, Calif.

Arthur Hansen, head, Nucleonics Section, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y. **Donald Taylor** and **Calvin Silverstein**, assistants to Mr. Hansen.

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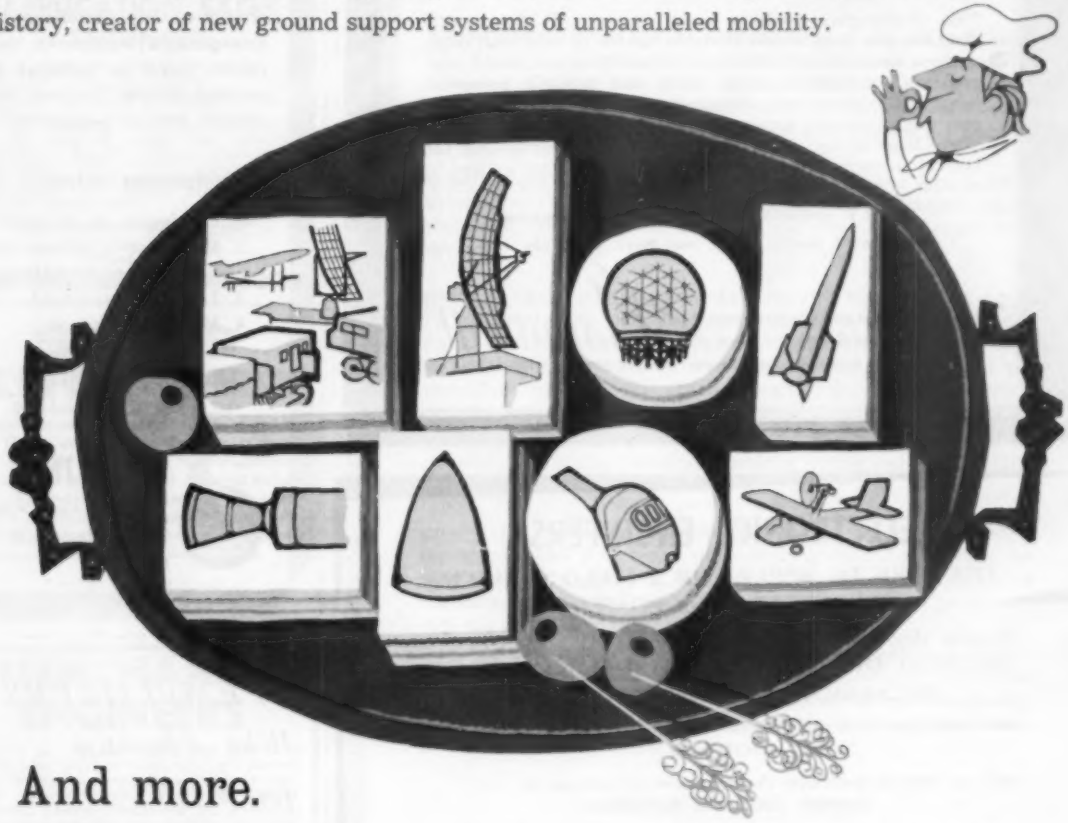

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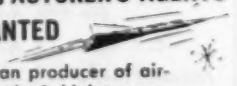

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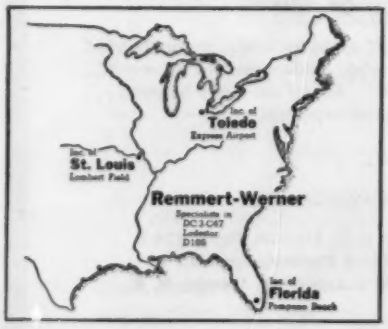

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LETTERS

Missile Comment

We have read with interest your editorial, "Missile Industry Myth Fades," in the Nov. 10 issue of AVIATION WEEK.

We certainly agree with you that the concept of ". . . a new and separate industry, having no roots in the technological past . . ." is a false one. However, we question the implication that the aircraft companies are virtually alone in holding prime contracts for ". . . major missile weapon systems now in advanced development or early production . . ."

In listing prime contractors in the missile field, we feel you have given inadequate recognition to the electronics manufacturers who have prime responsibility for such missiles as the Nike family, Sergeant, Sidewinder and Talos, as well as Raytheon with its Hawk and Sparrow III programs. It would be difficult indeed to argue that these weapons can be omitted from any consideration of the nation's missile arsenal.

It is no mere coincidence that Raytheon, for example, as an electronics manufacturer holds prime contracts for two important missile programs, and in the case of Hawk, what is probably the most comprehensive systems responsibility ever assigned to a missile contractor. Raytheon's missile activities, now carried on by over 12,000 employes in seven plants and laboratories, are truly "rooted in the technological past," dating back 14 years to the establishment in World War II of the company's pioneering "Lab 16." It was a Raytheon-developed guidance system growing out of this early work that achieved, in 1950, history's first successful interception and, in 1951, the first destruction of an airplane by a guided missile. The aviation and electronics industries have each proved their capability as prime contractors. We feel sure that each will continue to do so in the future.

RICHARD P. AXTEN
Director of Public Relations
Raytheon Manufacturing Co.
Waltham, Mass.

'Pot Shots'

I have been an ardent reader of AVIATION WEEK for many years. Being a military pilot with a little experience in the air transport business, I have taken interest in reading Capt. R. C. Robson's "Cockpit Viewpoint." Although I don't always agree with his opinions, I do believe his article "Control Battle," in the Nov. 10 issue of AVIATION WEEK was one of his finest.

It has grieved me personally for years to see military and commercial pilots take oral "pot shots" at each other. I have felt that usually they do not know the other persons' problems and, therefore, are not really qualified to sound off. Military and commercial pilots can learn a lot from each other if they want to. I know I have learned a lot from commercial pilots.

Capt. Robson's comments about "Limited Knowledge" and ". . . the common sense, alert operation of aircraft" was very admirably put. I wish all pilots, particularly military and commercial, would heed his advice in all phases of aircraft operations and leave the "pot shots" to the experts. Capt. Robson, I am your greatest supporter.

R. W. MILLAR
Lcdr., USN
Charleston, S. C.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Bitter Pill

In all sincerity and with no attempt at "sour grapes," let me add a heartfelt "AMEN" to your Oct. 13 editorial, and a P.S. to all three "Letters." No one can deny that much house cleaning is necessary in all areas—CAA, military, civil aviation in all its forms, and the aviation industry. Nor can any of us point too strong a finger at the other; the daily pressure of our respective businesses has allowed us all to fall behind in the areas of mutual safety and mutual operating harmony. The few "OX-5 technicians" and worst yet, in my opinion, the 150 hr. Ercoupe Experts have too long influenced important facets of our planning and decisions. The military in its rightful preoccupation with combat readiness and its significant majority of relatively inexperienced pilots who are the youth we require has been slow in constructive progress toward safe integration of its aerial forces into the peacetime overburdened net. The airlines have too long kept financial and seniority considerations as blinders to more mutually compatible operations. And the aviation industry, like the automobile industry, only builds what you want to buy. If it costs an extra buck it seems that complete safety is the first "optional" that is scratched.

Not that our aviation fraternity isn't the most capable in the world today and probably providing more military security, convenience and comfort of travel and technological refinement for the taxpayers' dollar than anywhere else. It's just that we need to shake the deadwood out of the cockpits and conference rooms and, to use that old phrase that Bleriot probably originated, get those very good ones remaining "mission oriented."

From my humble background of only 18 years flying experience, it has been a bitter pill to observe the lethargy with which so many have faced the jet era. After considerable four-engine and twin-engine experience, it was my good fortune to participate in the original jet instrument instruction program, the original jet all-weather interceptor program, the jet day fighter and fighter-bomber programs. To have many of our ideas and recommendations considered then, and still at times today, as coming from stovepipe-tailed hot rodders by those few "lighthouse keepers" was a mighty frustrating experience. The jet bombers we fly today long ago disclosed the problems of tomorrow; the lessons were there but to be observed and heeded. It frankly does my heart good to read that PanAm is unhappy about Idlewild's present ground rules. We've finally gotten the "big boys," to whom the controlling powers have always catered for well known reasons, to shoulder the pack and now people are listening. It's too bad more haven't listened during the past 10 years when we've been forced to fly our jets on routes, in patterns, and in configurations which were definitely not the most operationally effective or safe. Too long has there existed the general impression that primary right of way on the taxpayers' aerial highways belonged to the private vehicle of an influential private airline business guided unerringly by a solid driver whose degree of skill and experience was directly proportional to the amount of gray hair under his natty cap. Thank heavens for the Federal Aviation Agency.

No one can refute the theoreticians' computations which tell us the day of "see and be seen" is almost gone. But let's not go overboard on this thing. Anyone who has devoted any time to the jump-seat of our military and civil carriers can vouch for the surprising lack of visual and mental awareness of other traffic which too often exists. The attitude that an IFR clearance on a bright spring day has reserved for you, and you alone, a private piece of sky appears to be amazingly habit forming. The pleasant eye-to-eye chit-chat that breaks the monotony of long, routine flights is so commonplacely tolerated. When one second's inattention can kill you it's easy to get the impression that a few of us fly-types are bent on mass suicide. And, of course, we do have the "funny books," official or otherwise.

This bit about mental awareness of other traffic. How many times are we on company frequency when we should be monitoring airways or tower? How about the lads that have Lucy and Desi tuned in to pass the time? Or the troops that once at cruising altitude take off those earphones or earplugs, replacing them only when a compulsory call is necessary? This shakes you up almost as much as the oldtimer who uses prescription glasses for takeoff and landing, but takes them off at altitude while the co-pilot is in back reassuring the passengers!

Let's face it—there are too many of us who just don't know what looking around means and aren't concerned enough about it to work at it. And this condition seems to come too often with the gray hair. If more of us up front would pay more attention to staying alive, more of us probably would. Incidentally, I just recently got a crewcut because my own gray hair was showing.

Those of us who knew and respected General Quesada during World War II and the years since wish him the best of luck in the big job. Eventually we'll get what we need, but with "Pete" at the throttle working up a team and a program all on the same frequency we'll get it a lot faster and safer.

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P.S. Your Oct. 13 issue was just so very fine that for the first time in my life I had to thank the editor. Your publication, without a doubt, leads the aviation news field. Keep up the outstanding work.

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